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The  
Eighteenth  
Annual Report.

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VOLUME NO. 18  
OF THE  
Maryland Agricultural Experiment Station,  
COLLEGE PARK, MD.  
1904-1905.

THE  
**Maryland Agricultural Experiment Station.**

CORPORATION.

The Board of Trustees of the Maryland  
Agricultural College.

**Agricultural (Station) Committee of the Board of Trustees.**

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**Station Officers and Staff.**

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| HARRY J. PATTERSON, B. S.....   | <i>Director and Chemist.</i>                            |
| SAMUEL S. BUCKLEY, D. V. S..... | <i>Veterinarian.</i>                                    |
| W. T. L. TALIAFERRO, B. A.....  | <i>Agronomist.</i>                                      |
| CHARLES F. DOANE, M. S. Ag..... | <i>Dairy and Bacteriology.</i>                          |
| J. B. S. NORTON, M. S.....      | <i>Botanist and Pathologist.</i>                        |
| E. O. GARNER.....               | <i>Farm Superintendent and Recorder of Experiments.</i> |
| THOS. B. SYMONS, M. S.....      | <i>Entomologist.</i>                                    |
| WM. N. HUTT, B. S.....          | <i>Horticulturist.</i>                                  |
| F. H. BLODGETT, M. S.....       | <i>Assistant Botanist.</i>                              |
| M. N. STRAUGHN, M. S.....       | <i>Assistant Chemist.</i>                               |
| A. B. GAHAN, B. S.....          | <i>Assistant Entomologist.</i>                          |
| E. P. WALLS, B. S.....          | <i>Assistant Agronomist.</i>                            |
| STEWART B. SHAW, B. S.....      | <i>Assistant Horticulturist.</i>                        |
| JOSEPH R. OWENS, M. D.....      | <i>Treasurer.</i>                                       |
| HERBERT H. HOWELL.....          | <i>Clerk.</i>   |
| THOS. H. WHITE.....             | <i>Gardener.</i>  |

The Station is located on the B. & O. R. R. and City & Suburban Electric Car Line, eight miles north of Washington, D. C.

Bell Telephone—Washington Directory—Hyattsville 42.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

ADDRESS:

, AGRICULTURAL EXPERIMENT STATION,  
College Park, Maryland.

THE  
EIGHTEENTH  
ANNUAL REPORT

OF THE

MARYLAND

Agricultural Experiment Station,



COLLEGE PARK

PRINCE GEORGE'S CO.,

MARYLAND.

1904-1905.

PUBLISHED BY THE STATION.

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AGRICULTURAL EXPERIMENT STATION,  
College Park, Maryland.

### LETTER OF TRANSMITTAL.

To His Excellency, Edwin Warfield,  
Governor, and President of the Board of Trustees,  
Annapolis, Md.

Sir:—In accordance with the provisions of Section No. 3, of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations, etc.," I have the honor to transmit the Eighteenth Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1905.

Very respectfully yours,

H. J. PATTERSON,

July, 1905.

Director of the Experiment Station.

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# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

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Volume 18.

1904-1905.

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## Report on the Work and Expenditures of The Maryland Agricultural Experiment Station.

FOR THE YEAR ENDING JUNE 30, 1905.

By H. J. PATTERSON, Director.

In general, the Experiment Station of this State may be said to be in a satisfactory and healthy condition, as is evidenced by the constantly increasing number of farmers who are taking an interest in the investigations in progress, and asking for our publications, and, also, looking to this place, by correspondence and visits, for help on every conceivable question with which farmers may come in contact.

### EXPERIMENTS IN PROGRESS.

It is rather difficult to convey an adequate idea of the various investigations in progress, and their economic importance, within the compass of a report of this character; but a brief outline may serve to show the wide range covered by the experiments, and, it is hoped, that every farmer in the State will make it a point to go over the work in detail whenever opportunity may present.

In going over the list of investigations covered by the various departments, it must be remembered that, in most cases, the men in charge of the different experiments also have duties as teachers in the college and State police work. Consequently, this variety of requirements must necessarily limit the amount of work which can be undertaken, and, also, make the progress much slower than when men give undivided attention to their investigations. Again, it must be remembered that the funds of this Institution are limited, which, with the variety of agricultural interests to be recognized in Maryland, makes the work of each department more or less circumscribed; and that these facts must be taken into account, if occasion should arise, for comparing the work of this Station with that being conducted in the U. S. Department of Agriculture, or with those stations in other States where they can concentrate almost their entire effort on one or two subjects.

## AGRONOMY.

The work in this department has continued to be concentrated on the three chief staple crops of the State, viz: corn, wheat, and hay and forage crops. These three crops represent considerably more than one-half the income from Maryland's farms. The investigations with these crops are being constantly broadened and enlarged, and, while the time of one more man has been given to this work during the past year than previously, yet it has not been possible to keep up with the increasing demands from all parts of the State for help on these crops, and experiments with them.

During the present season there are nineteen different field-corn breeding experiments in progress, distributed as follows:

|         |                                 |
|---------|---------------------------------|
| 4 acres | on the Experiment Station Farm. |
| 3 "     | in Frederick county.            |
| 3 "     | in Queen Anne county.           |
| 4 "     | in Caroline county.             |
| 2 "     | in Harford county.              |
| 1 acre  | in Baltimore county.            |
| 1 "     | in Charles county.              |
| 1 "     | in Montgomery county.           |

## CHEMICAL DEPARTMENT.

The Chemical Department during the past year, has been occupied chiefly with investigations relating to sweet corn and field corn problems, though considerable time has been given to various other matters.

During the year 971 samples have been received into the laboratory, these being classified as follows:

|                 |               |     |
|-----------------|---------------|-----|
| Sweet Corn      | { Dried.....  | 379 |
|                 | { Green.....  | 38  |
|                 | { Canned..... | 36  |
| Field Corn..... |               | 480 |

Miscellaneous samples, 38, consisting of:

|                         |    |
|-------------------------|----|
| Cattle Feed (conc)..... | 9  |
| Soils.....              | 10 |
| Limestones.....         | 3  |
| Water.....              | 4  |
| Corn.....               | 3  |
| Paris Green.....        | 5  |
| Wood Ashes.....         | 2  |
| Weed Destroyer.....     | 1  |
| Egg Preservation.....   | 1  |

The examination of these samples, together with the special investigations in progress, involved over 2,700 determinations.

Records of the work have been kept, and all results will be published.

The breeding of sweet corn upon the general plan pursued with field corn has been started this season, and the detailed supervision, for the present, is being followed by Mr. Straughn.

The objects of the investigation are:

- 1st. To induce the canners to grow their own sweet corn seed.
- 2nd. By careful selecting and breeding to secure a corn high in sugar content—a long and narrow grain, and one which will be bright when canned, and command the highest price on the market.
- 3rd. To increase the tonnage per acre, and pack per ton.

A thorough investigation on the composition of sweet corn was begun last year, as nothing of consequence could be found on record relating to the chemistry of sweet corn. Forty varieties of corn were secured from various parts of the country; and, besides the usual fodder analysis of moisture, ash, protein, crude fiber, and fat, we determined the different sugars present, the pentosans, and starch; and, also, made special examinations of the oils. Studies are now in progress of the effect of climatic conditions upon the chemical composition.

This year we have nine breeding plots, one of which is located at the Station; three at Mr. F. P. Roe's, of Greensboro, Md.; three at Mr. W. Scott Whiteford's, Whiteford, Md.; one at Mr. George E. Silver's, Churchville, Md., and one at Mr. George E. Bishoff's, of Hoyes, Garrett county, Maryland.

The thanks of the Station are due these gentlemen for the interest taken in these experiments, and for the courtesies they have extended.

These breeding plots are of the same size as the field corn breeding plots, and each row represents a specially selected individual ear. Samples are to be taken from each row, when ready for packing, and analyzed in the green state; another sample canned, afterwards analyzed, and the remainder examined after maturing for seed. From this data we hope to establish any relation which may exist between the green, canned and dried corn.

Some co-operative work on sweet corn is being carried on with the Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

The investigations on soluble salts in Maryland soils have been suspended for the present, owing to lack of time, but will be continued in the future.

The following investigations, which have been in progress for several years, are continued under the supervision of this department:

1. Experiments in pig feeding.
2. Experiments in calf feeding.
3. Fertilizer experiments with lime.
4. Fertilizer experiments with different kinds and sources of phosphoric acid.
5. Experiments with potash fertilizers.
6. Experiments with nitrogenous fertilizers.

## DAIRY DIVISION.

This department has been quite active during the past year, and has completed several of the investigations which were mentioned in the last year's report, besides some others, as is evidenced by the bulletins (see bulletin list of publications) published during the past year on dairy subjects. Besides the bulletins published, the manuscript is in hand for a bulletin from this department giving the results of a test of various bedding materials for cattle.

Besides the completed investigations, as represented in the bulletins from this department, there has been considerable data in feeding, etc., collected during the year.

Mr. Doane, who has been in charge of the dairy investigations at this Station, for the past seven years, handed in his resignation to take effect June the 1st, in order to accept a position in the Dairy Division of the United States Department of Agriculture, Washington, D.-C. The place which he accepts not only pays him more, but allows about ten thousand dollars per year for his particular experiments and consequently, gives him a greatly enlarged field for work. After the present year Mr. Doane's work will be mainly with city milk supplies, and probably most of the work will be performed in Washington and Baltimore, which may give this Station an opportunity, by some plan of cooperation, to avail of the results of these experiments for Maryland people.

## HORTICULTURAL DEPARTMENT.

The vacancy in the position of Horticulturist, caused by the resignation of Prof. Austin, was filled by the appointment of Prof. Wm. N. Hutt, of Guelph, Canada, who took charge of the department in November, 1905. Prof. Hutt reports that he has adopted the policy of continuing, as far as possible, the investigations already in progress, and to enlarge the work, as far as practicable, only after a careful study of the horticultural conditions of the State.

Before Prof. Austin's departure, in July, 1904, the field work had been planned out and put in operation for the season. This work was well looked after by Mr. White, who kept the notes and completed the records for the year.

The experiments now in progress are as follows:

## 1. COOPERATIVE STATE WORK.

1. Cooperative tests as to the relative value of Muriate of Potash and Sulphate of Potash on apples, pears, peaches and plums.

These experiments are conducted on the farms of Jas. S. Harris, Coleman, Kent County; Caleb Long, Boonsboro, Washington County; Sam'l S. Stouffer, Sharpsburg, Washington County.

2. Cooperative tests on the effect of "Nitro-culture" on the production of peas and beans for canning purposes.

These tests are made by F. P. Roe & Brother, Greensboro, Caroline County, and B. F. Shriver, Union Mills, Carroll County, Maryland.

## II. GREENHOUSE WORK.

1. Carnation work to determine:
  - a. The value of different fertilizers.
  - b. The value of raised benches compared with solid beds.
  - c. The best time for setting plants.
  - d. Subirrigation as compared with surface watering.
  - e. How to strengthen the stems.
2. Tomatoes: To determine the distance apart, culture and training, to take the maximum weight off each square foot of bench.
3. Lettuce: To study methods of culture to produce maximum crop and to avoid disease.
4. Chrysanthemums: Cultural methods to produce the maximum crop of perfect blooms.
5. Tests of different methods of making greenhouse soils.

## III. FRUIT TESTING.

1. A study of the best varieties and of cultural methods of Currants, Gooseberries, and Raspberries.
2. Strawberries:
  - a. Variety test.
  - b. Test of covering and mulching.
  - c. Test of crosses made by Mr. White.
3. Cover crops on the growth and productiveness of apples.
4. Grapes. A new vineyard of many varieties has been started. This is to ascertain the practicability of raising grapes in this region. In putting up the trellis, five different methods of training have been put under test.
5. Pears: Breeding to obtain better and more blight-resistant varieties.

## IV. VEGETABLE CROPS.

1. Asparagus: Test of fertilizers.
2. Onions: Test of new and old methods of culture.
3. Irish Potatoes: Variety tests to determine disease resistant types.
4. Sweet Potatoes: To determine the effect of the continuous use of the same land.

5. Fertilizer tests on various truck crops: Corn, peas, beans, etc. Before offering further suggestions for expanding the work, it is Prof. Hutt's intention to travel extensively over the State and make a careful study of the horticultural conditions.

During this summer he expects to give special attention to the subject of preparing, packing and shipping fruit to market. In study-

ing this work, it is planned to see all classes of fruit packed in the orchards in this State, to follow the shipments to the great northern markets, and to note the condition of the fruit when exposed for sale. This is a side of the fruit business to which very little experimental attention has been given.

During this winter, a preliminary study was made of the effect of frost on fruit buds. Next season it is hoped to carry on this work on a larger scale and to publish the results in bulletin form.

An arrangement has been made with the heads of the departments of Entomology and Pathology which is designed to bring them more closely in touch with the work of experimental horticulture. Periodic examinations, perhaps weekly, will be made on the horticultural grounds to determine the presence of insects or fungous enemies. Co-operative measures will be taken to combat these injuries.

## DEPARTMENT OF BOTANY AND PLANT PATHOLOGY.

The work necessitated by the provisions of the State Horticultural Law takes a large part of the time of the officers of this department.

The usual nursery inspections were made during 1904, for fire blight of apple, pear, and quince; peach yellows, Crown gall and Black Knot. Fire blight was found, in some cases, in low ground. Leaf blight was destructive, as in the previous year, to certain varieties of pear, and to cherry and plum, but it is not likely to be carried to orchards and nurseries. Black knot is occasionally found in nurseries. Crown gall is very common in many nurseries. Before receiving a certificate the nurserymen agree to throw out trees affected with gall enough to be injurious in the orchard.

A disease of certain varieties of plums was seen frequently in the nurseries, in which sunken canker-like areas form in the twigs, and cause them to weaken or the trees to make little progress.

The Department has inspected in orchards about 1,000,000 trees for yellows, blight and other diseases. About 800,000 peach trees were examined in these orchards and 17,110 found to be diseased with yellows, or about two per cent. Blight was bad in isolated cases, especially about towns.

The usual visits have been made to all parts of the State. An increasing number of inquiries regarding Maryland plants, and plant diseases and their treatment, have been received and answered at this office. Much has been done towards a thorough knowledge of plant diseases in this State by our correspondents, who sent specimens for examination and have prepared reports on local condition, and it is hoped that many others will do so. A new form of report blanks, making it easy for our correspondents to make out monthly or annual reports of the effect of diseases, and many points of interest concerning them has been sent out to a special list of those most interested in such work throughout the State, and it is of much value in collecting statistics for our reports and investigations.

The appointment of the Assistant Pathologist, in connection with similar arrangements in a few other experiment Stations, as collaborator in Vegetable Pathology, (U. S. Dep't Agr.) which will react to the benefit of this Department, through the co-operation in respect to herbarium specimens of diseased plants, etc. The details of this work are not perfected, as yet, but they incur almost no additional work on the part of the collaborator, except by correspondence, the regular trips, etc., being utilized in the new work with very little change.

In connection with the Maryland Weather Service, this department has taken part in a Botanical Survey of the State. During August and September, Mr. M. A. Chrysler was engaged in this connection in exploring St. Mary's and Calvert counties, and this summer he will work in other parts of the Coastal plain of Maryland. The department herbarium has been selected as the depository of the plants collected in this survey.

Investigations in Plant Pathology during the year have been as follows: 1. A study of the distribution and abundance of all the principal plant diseases in the State, and their effect on crops. 2. Investigations of the effect of crown gall in the orchard, and soil treatments for the same. 3. Investigation of structure of certain abnormal pea vines (F. H. Blodgett). 4. Peach Rot (sclerotinia stage). 5. Tests for spraying methods, and materials for various diseases, testing especially the dust sprays. 6. Studying varieties of fruits resistant to diseases. 7. Investigations on bark diseases of peach and apple, (see publication by F. H. Blodgett in Report of Maryland Horticultural Society 7: 140). 8. Cabbage rot investigations (Experiment begun 1905 by Assistant F. H. Blodgett with T. B. Todd, North Point, to counteract heart rot with field treatments).

Several trips were made to investigate troubles, notably in connection with a clover disease near Chestertown, due probably to a fungus of the leaf. This is still under observation. A more recent trouble is that in the vicinity of Brunswick where several contract orchards have died or are doing so, apparently from too deep planting combined with too old trees as set.

A greenhouse has been built for pathological experiments. Many specimens of diseases were furnished for the pathological exhibit at the St. Louis Exposition and, whenever possible, we have co-operated with the investigators in other states and at Washington, D. C., by furnishing notes, samples, cuts, photographs, etc., and many favors of similar nature have been extended to us by other plant pathologists.

The usual plan of giving instruction to the local inspectors at the department laboratories, has been carried out with success.

The kind co-operation of many horticulturists, orchardists, nurserymen and gardeners in our inspection work, in answering inquiries, and in aiding in experiments has much facilitated the work of this department.

## DEPARTMENT OF ENTOMOLOGY.

The work of this department may be classified as follows:

1. Orchard and Nursery inspection.
2. Class-room.
3. Investigations.

In the investigations the following insects have received special attention.

*San Jose Scale*: The results which have been obtained during the past two years, and which have been reported upon in Bulletin 90 and 99, show quite conclusively that this insect can be controlled by thorough and systematic spraying, with Lime, Sulphur and Salt solutions, yet as the past few months have seen so many "patented" insecticides and modifications purposed for making Lime, Sulphur and Salt solutions it appeared desirable to make further practical tests of these materials. These tests are being carried on in the vicinity of College Park, Cambridge, Harmans, Laurel and Patuxent.

The Entomologist is conducting some cooperative experiments with the United States Department of Agriculture on this subject.

*Oyster Shell Scale*: While it has been the common practice for Entomologists to recommend caustic washes applied in late winter, and early spring, for this scale, yet there has not been many direct experiments testing this treatment. Accordingly, an experiment testing the treatment has been conducted at Swanton, Maryland, on an apple orchard containing about 500 trees badly infested with this scale.

*Codling Moth*: The great loss occasioned each year to apple fruit, by this insect, has prompted the inauguration of some experiments this spring, in order to procure fuller information of the life history and number of generations of the insect in this State, and, also, the practicability of the remedies which are given for its control.

*Woolly Aphis*: Owing to the enormous amount of injury that this insect causes, both in the nursery, as well as in the orchards of the State, an experiment is in progress employing different treatments for the control of the pest. Over 2000 apple seedlings and grafts have been planted out on the Station farm this spring, and a much larger number of nursery trees at a large nursery in the State have been employed for this experiment.

The life history of the peach tree borer is under observation in order to determine exactly when the adult insect appears in the different parts of the State which is preliminary to a further investigation for its control.

A study of the strawberry root-louse, as reported last year, is still in progress. The life history of the Imported Currant Worm and the Red Spider are being studied.

*Mosquitoes*: The constant annoyance of this class of insects, to a large part of the population living in the many parts of the State, where the natural conditions are most favorable to their increase, as well as in many places where no means are taken to destroy their breeding places, together with the comparatively recent discoveries that certain species convey malaria and yellow fever, makes the study of these

insects very important. This department will take up the following investigations conjointly with Mr. T. H. Coffin, who is working with Dr. Howard A. Kelly, of Johns Hopkins University.

First: To inform ourselves as to just what species of mosquitoes exist in the State. Under what conditions they live and which of them are the more troublesome, either as carriers of disease or as annoyances.

Secondly: To work over the life history and learn the number of broods and, also, observe whether the breeding areas are general or restricted.

Thirdly: To make a study of the natural enemies of the mosquitoes.

Fourthly: As far as circumstances will permit, to conduct experiments with different materials for their control, and to employ methods for amending conditions which are favorable for their development.

*Fumigation*: As considerable agitation has been manifested in the State, as to the effect of the Hydrocyanic acid gas treatment, on fruit trees sold from the nurseries, it was desired to conduct experiments to fully demonstrate the effect of the gas upon the different varieties of peaches and apples, fumigating both in the fall and the spring. 1400 trees have been used in the experiment, and they are now planted out on the Station farm.

A full report of these experiments will be published as conclusive results are obtained.

## VETERINARY DEPARTMENT.

The work of this department for the past year has been conducted upon the usual lines. The various cases of sickness among the farm animals, have received treatment by customary methods, and, with the exception of a fatal case of pneumonia associated with tetanus, all terminated favorably.

The limited amount of time available for experiment work has made it impossible to pursue extended research studies, and only two important lines of work were undertaken.

### EXPERIMENTAL WORK.

Assistance was given the Dairy Department in the study of Leucocytes as affecting the character of the milk and disease of the udder. This work is practically new, as regards the nature of the investigations here made, and certain details connected with the work developed the fact that information along many lines is extremely limited. An extended study of the udder, its functions and affections is desirable and important, on account of its bearing upon the wholesomeness of milk and the transmission of disease through dairy products.

*Tuberculosis*: Work has been begun to verify that of Prof. E. Von Behring, director of the Marburg Institute for Research against infectious diseases, Marburg, Germany, in the immunization of cattle against tuberculosis. Prof. Welch of Johns Hopkins spoke of it as "one of the most important pieces of scientific work of the present

time" and the demonstration of it as a practical measure, as early as possible, is desirable. At this time eight calves have received the first inoculation, and the second and final inoculations will be made in July.

There seems to be no reason, as yet apparent, why this method of dealing with the problem of tuberculosis will not become general. Of all plans so far advocated this promises the most favorable results. While certain objections have been made against its adoption, and unfavorable objections have been raised, yet no proofs have been adduced which counteract the claim that it immunizes for a long period or for life. The very fact that the conferred immunity is obtained through living organisms, and not dead ones, nor the products of organisms, furnishes hope for prolonged immunity.

Regardless of technicalities upon which the discussion of the human and bovine tuberculosis is based, it is beyond question that cattle can contract tuberculosis from virulent human organisms, and it is a fact that cattle do not attenuate such organisms when grown within their bodies—so that it must be possible for a human being to contract tuberculosis through inoculation from such a cow. Bovine tuberculosis from bovine origin is regarded as more virulent than bovine tuberculosis from human origin, and the probability is that human beings are susceptible to infection from that source.

Absolute proof is hardly likely to occur, but sufficient evidence is at hand to justify all possible precautions in the use of infected flesh and dairy products.

The studies upon the udder and its secretions above recommended, bear directly upon this question and are essential factors in determining the full value of this method of immunization.

## CO-OPERATION AND DEMONSTRATION EXPERIMENTS.

The facts as set forth in last year's report become more and more apparent each year, and nothing better can be offered than to renew these suggestions and recommend that steps be taken to carry them into effect as soon as means of doing so are available.

## PUBLICATIONS.

The bulletins and reports of the Station represent the detailed history of the results of the investigations conducted, and, when considered in this way, should merit more careful preparations and printing than is commonly accorded, and it is sincerely hoped that time and money may soon be available to carry out both these ideas.

The following are the publications issued during the past year:

July, 1904.—Seventeenth Annual Report.

July, 1904.—Bulletin No. 94. "Methods of Keeping Milk and Butter Records;" by Charles F. Doane.

August, 1904.—Bulletin No. 95. "The Character of Milk During the Period of Heat;" by Charles F. Doane.

September, 1904.—Bulletin No. 96. "Sweet Corn Breeding; Growing and Curing for Seed;" by Dr. Augustus Stabler, Brighton, Md.

- October, 1904.—Bulletin No. 97.—“The Relative Profits of Selling Milk, Cream and Butter;” by Charles F. Doane.
- November, 1904.—Bulletin No. 98. “Home-grown Protein for Feeding Cows;” by Charles F. Doane.
- December, 1904.—Bulletin No. 99. “Spray Solutions for San Jose Scale;” by Thomas B. Symons.
- March, 1905.—Bulletin No. 100. “The Wild Legumes of Maryland and Their Utilization;” by J. B. S. Norton and E. P. Walls.
- April, 1905.—Bulletin No. 101. “Common, Injurious and Beneficial Insects of Maryland;” by Thomas B. Symons.
- May, 1905.—Bulletin No. 102. “The Leucocytes in Milk and Their Significance;” by Charles F. Doane.
- June, 1905.—Bulletin No. 103.—Methods for Selecting and Testing Tobacco Seed;” by W. W. Cobey.

In addition to the regular bulletins, the entomologist and pathologist have issued the following circular bulletins:

- Circular Bulletin No. 59.—“Botany in the Public Schools;” by J. B. S. Norton.
- Circular Bulletin No. 60.—“Fall Treatment for San Jose Scale;” by Thomas B. Symons.
- Circular Bulletin No. 61.—“Winter Work Against Fruit Diseases;” by J. B. S. Norton and Frederick H. Blodgett.

Besides the above there is now in manuscript form, one more bulletin from the Dairy Department (see pp. No. 5), and enough complete data to compile at least ten other bulletins. This matter only awaits the time of the men to put them in shape and the money for printing after it is prepared.

### MAILING LIST.

The demand for the Station bulletins is constantly growing, and in order that everyone who desires them may get them without confusion, plans are being made to carry out the suggestions made in my last annual report, which was adopted by the Board at its December meeting.

In going over the various mailing lists, more variations were found than were anticipated, and it is probable that when the general mailing list is revised, and all new names added, that it will contain eighteen to twenty thousand addresses.

### BUILDINGS.

The repairs authorized at the last annual meeting have been made, and the small six-room house has been contracted for and will be put up during the summer. This house will be built at a cash outlay of about \$700.

### STATION EXHIBITS.

The exhibits showing the results of the Station work at the county fairs and other farmers' meetings, have been continued during the past year on much the same plan as outlined in previous reports. This

feature of our work has brought us closer in touch with many farmers, and seems to be much appreciated.

In this class of work it is necessary to make changes from time to time so as to present not only something new, but old facts in new form. Consequently, this work needs careful attention and supervision by experienced persons wherever possible. In order to provide for this work on a better basis than by employing recent graduates as in the past, I recommend that I be given permission to make arrangements with Mr. W. L. Amoss to take charge of it this season. Of course, with the understanding that in so doing, it will not interfere with his regular duties as director of Farmers' Institutes. The plan of having Mr. Amoss look after this work, I believe will give us much better service, with no more expense than the plan pursued in the past. In asking Mr. Amoss to take charge of the exhibit work, it is not intended to transfer this part of the Station's work to the Farmers' Institute Department, nor to have it pass from under the control and supervision of the Station; for these exhibits are a demonstration of the experimental work and results obtained by the Station and could only be carried out successfully when under Station control.

### SEED CORN SPECIAL TRAINS.

As a result of some correspondence between Governor Warfield and myself, he kindly placed before the proper railroad officials of the different systems in Maryland some facts which showed what the Experiment Station could do for the advancement of agriculture in the State through exhibits and lectures, and brought to the attention of the railroad authorities what they could do to further this work.

The interest which the Chief Executive of the State showed in our institution gave us a favorable introduction to the railroad Presidents, and caused them to give us consideration which had never before been received. About this time I had some correspondence with Mr. C. Boslev Littig, of the Baltimore Chamber of Commerce, in which he mentioned the notices he had seen of the Special Corn Trains being run on different Western railroads, and in reply I told him that we had just as valuable results from our experiments, and which we would be glad to place before Maryland farmers in the same way. Mr. Littig talked over this matter with his personal friend, Mr. J. S. Norris, General Manager of the Maryland and Pennsylvania Railroad, and then called me over to Baltimore, and we both had a conference with Mr. Norris which resulted in the first "Seed Corn Special Train," which was run over the Maryland and Pennsylvania Railroad, from Baltimore to Red Lion, Pennsylvania, on March 31 and April 1.

In consequence of a letter from Vice-President Landstreet, of the Western Maryland Railroad, which Governor Warfield turned over to me, I wrote to him and obtained the promise of a "Seed Corn Special Train," for two days over that road. This train was run on Friday and Saturday, April 7 and 8. In both cases the trains were officially granted to the Experiment Station.

As this work was in the nature of a Farmers' Institute, I asked Mr. Amoss to go with us and take charge of the details of the trips, which he accepted. In order to be sure that he would have sufficient lecture force and also to have someone who had already had experience on the "Seed Corn Specials" of the Western states, I procured, through the courtesy of the United States Department of Agriculture, Washington, D. C., the help of Mr. A. D. Shamel and Dr. H. J. Weber, both of the United States Department of Agriculture Plant Breeding Laboratory.

The lectures given on the "Seed Corn Special" trains were heard by 2107 persons, or an average of eleven persons to each mile of railroad traversed, were well received, and favorably commented upon both by individuals and the press; and I believe they will be productive of a great deal of good to the State and the railroads. The success of these trains demonstrated that this plan of carrying and disseminating information to farmers is valuable and practical. "The Seed Corn Special" trains have awakened a very general interest all over this and adjoining States, and have been the means of widely and substantially advertising this institution, and will undoubtedly mark a new era in our agriculture.

#### ADDITIONAL HELP FOR STATIONS.

In connection with appropriations from the State for Agricultural investigations, it may be well at this time to consider the advisability of seeking further help from the next Legislature which is to meet the coming winter.

There are a great many things which are needed, and a good many places where money could be spent. Yet on the whole I believe the Station stands more in need of money for use in conducting and enlarging the investigations rather than funds for buildings.

More equipment in the way of buildings would be useful, but this sort of help means a greater draw on the funds, which we already have for maintenance and, consequently, in a measure curtails the actual amount available for real research. Consequently, if only one kind of appropriation can be had, it is better to get it for research. Again, money gotten for research should be made an annual allowance, as it then permits of work being planned on a broad and comprehensive scale. The place where more money could be used to best advantage is in connection with plant breeding and development in the departments of agronomy and horticulture.

#### STATION STAFF.

The vacancy in the position of Horticulturist as previously noted was filled by the appointment of Wm. N. Hutt, B. S., a graduate of Guelph, (Canada), Agricultural College, and for two years Horticulturist of the Utah Agricultural College and Station. Prof. Hutt grew up on a fruit farm near Niagara Falls, and after graduation was assistant director of Farmers' Institute in Canada, and editor of the Canadian Horticulturist. He has taken hold of the work at this place with intel-

ligence and great enthusiasm, and is placing it upon a very good basis. He is being very well received by the horticulturists of this State.

E. P. Walls, B. S., a graduate of this college, Class 1903, was appointed Assistant Agronomist.

Stewart B. Shaw, B. S., a graduate of this college, class of 1904, was appointed Assistant Horticulturist.

Charles F. Doane resigned June 1 from the position of Dairy Bacteriologist of this Station, to accept a position in the Dairy Division of the United States Department of Agriculture, Washington, D. C. His new position not only pays a larger salary, but gives a much larger field for work, and considerably more money to work with.

I would call your attention to the facts set forth in last year's report, as to the disposition of the Federal authorities on the question of the principal investigators serving in dual capacities. While it is not expedient at this time to have an entirely separate Station force, yet it would seem from experience here, as is evidenced from the publications issued, the aim should be to get considerable working force, with little else to do except the pursuit of the investigations in hand. The idea that classroom experience will keep an investigator alert, and in touch with his subject, does not work out in practice. It is better to depend on a few days at Farmers' Institutes and to visiting farms for this producing up process.

#### FINANCIAL CONDITION.

As will appear from the report of the treasurer, the fiscal year will close with all the bills paid. I have carefully gone over the probable expenses for the coming year, and believe that the Station's funds will permit of a continuation of the investigations in force at present, and the carrying out of all the recommendations made to the Board of Trustees.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN  
ACCOUNT WITH THE UNITED STATES  
APPROPRIATION.

DR.

1905.

June 30. To receipts from the Treasurer of the United  
States, as per appropriation for the fiscal year  
ended June 30, 1905, as per act of Congress  
March 2, 1887..... \$ 15,000.00

CR.

1905.

|  |             |
|--|-------------|
| June 30. By Salaries.....                | \$ 8,252 57 |
| “ Labor .....                            | 2,830 58    |
| “ Publications .....                     | 183 72      |
| “ Postage and Stationery.....            | 322 07      |
| “ Freight and Express.....               | 310 87      |
| “ Heat, Light and Water.....             | 367 47      |
| “ Chemical Supplies.....                 | 207 91      |
| “ Seeds, Plants and Sundry Supplies..... | 135 09      |
| “ Fertilizers .. ..                      | 195 42      |
| “ Library .....                          | 383 24      |
| “ Feeding Stuffs.....                    | 560 65      |
| “ Tools, Implements and Machinery.....   | 74 13       |
| “ Furniture and Fixtures.....            | 2 80        |
| “ Scientific Apparatus.....              | 167 20      |
| “ Live Stock.....                        | 285 00      |
| “ Traveling Expenses.....                | 517 13      |
| “ Contingent Expenses.....               | 15 00       |
| “ Building and Repairs.....              | 189 15      |
| Total.....                               | 15,000 00   |

The above is a true copy from the books of this office.

(Signed.) JOSEPH R. OWENS,

*Treasurer Maryland Agricultural Experiment Station.*

MARYLAND AGRICULTURAL EXPERIMENT STATION IN  
ACCOUNT WITH THE STATE OF MARYLAND  
APPROPRIATION.

Dr.

|  |                |
|--|----------------|
| July 1. To Cash Balance.....   | \$ 1,011 28    |
| 1905.  |                |
| June 30. To Receipts from the Treasurer of the State of<br>Maryland, for the fiscal year ending Septem-<br>ber 30, 1905..... | 5,000 00       |
|  | <hr/> 6,011 28 |

Cr.

|                            |                   |
|----------------------------|-------------------|
| June 30. By Repairs .....  | \$ 1,112 36       |
| " Publications .....       | 1,112 57          |
| " Exhibits .....           | 1,203 12          |
| " Feeding Experiments..... | 972 80            |
| " Tobacco Experiments..... | 189 63            |
| " Insurance .....          | 212,50            |
| " Cash Balance.....        | 1,208 21          |
|                            | <hr/> \$ 6,011 28 |

The above is a true copy from the books of this office.

(Signed.) JOSEPH R. OWENS,

*Treasurer Maryland Agricultural Experimental Station.*

MARYLAND AGRICULTURAL EXPERIMENT STATION IN  
ACCOUNT WITH THE STATION FARM.

Dr.

|  |                   |
|--|-------------------|
| July 1. To Cash Balance.....                               | \$ 2 13           |
| 1905.  |                   |
| June 30. To Sales of Stock and Produce since July 1, 1904. | 4,585 85          |
|  | <hr/> \$ 4,587 98 |

Cr.

|  |                   |
|--|-------------------|
| June 30. By Labor .....                  | \$ 2,800 00       |
| " Seeds, Plants and Sundry Supplies..... | 505 26            |
| " Feeding Stuffs.....                    | 500 00            |
| " Tools, Implements and Machinery.....   | 349 33            |
| " Live Stock.....                        | 200 00            |
| " Traveling Expenses.....                | 183 39            |
| " Contingent Expenses.....               | 50 00             |
|  | <hr/> \$ 4,587 98 |

The above is a true copy from the books of this office

(Signed.) JOSEPH R. OWENS,

*Treasurer Maryland Agricultural Experiment Station.*

# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 94.

July, 1904.

## Systems for Keeping Milk and Butter Records.

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C. F. Doane.

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This bulletin deals with an old subject, but it is a question that should interest every man who depends upon his dairy for a large part of his income, and who desires to increase the profits coming from his herd. Dairying is one of the most profitable branches of agriculture when worked to the limit of its possibilities, and it is not very probable that any dairyman is making as much as he should, unless he is keeping a careful record of the milk and butter yields of each individual cow in his herd. Scientific dairymen, as well as practical dairymen, may find material for consideration in that portion of this bulletin, tables and discussion, dealing with the proper months in the lactation period for securing a fairly average test when it is not desired to test every individual in the herd every month she is in milk.

Perhaps no single advancement along dairy lines has contributed so much to the profits of the industry as the keeping of herd records, which enable the owner to know the exact amount of milk and butter produced by each individual animal, and thus determine if she is kept at a profit or a loss. This system, where it has been applied, has sometimes doubled the actual profit received from a herd of cows, and in some cases has turned a loss to a substantial profit. The producing end of dairying has, in the past, and is even yet on many dairy farms carried on in a most unbusiness-like way. The fact that communities largely engaged in this industry are nearly always the most thrifty and prosperous appearing is no refutation of this assertion; rather it is an evidence of the possibilities of this branch of farming.

The lack of the application of business principles to dairying is due very largely no doubt to the fact that dairying is more complicated than most of the other agricultural pursuits. Then, too, the fact that dairying has given some profit under all but the most adverse conditions has rather led the farmers to believe that they were doing pretty well any way, and it was better to let a good thing rest as it was. It is very easy to tell if a bunch of fattening steers or hogs have paid for the corn they have consumed. A farmer can easily determine if a field of corn has produced sufficient grain to pay for the work and fertilizer. These calculations are simple, the results even obvious. It is

fairly easy to tell if a herd of dairy cows, taken as a whole, have paid for their food, though the problem has become a little more complicated, owing to the necessity of considering the value of the by-products, such as the skim milk and the manure. But to get the greatest value out of a herd one must go behind returns from the entire herd. It is not enough that the herd pays as a whole. The question concerns the product of each individual in the herd. Does every cow in the herd pay a profit on her feed? Fortunately, or unfortunately, as one may regard it, all cows do not produce the same quantity or quality of milk. Though they may belong to the same breed, or may be even closely related, they cannot be depended on to be equally valuable. This makes it necessary for each cow to rest upon her own merits, and for the owner to determine the individual merit of each animal. In this particular feature is where the greater number of dairymen fail to apply business methods. Many dairymen, who are thoroughly grounded in the scientific and practical end of feeding, who understand the importance of good care and good surroundings for the cows, have failed utterly to realize the value of this most important part of dairying, and fail to keep any record of what the cows in their herd are doing. It is doubtful if one dairyman in ten keeps any records whatever, except, possibly, a rough idea of the total amount brought in by the herd during the year.

This lack of knowledge of the value of each cow in the herd leads nearly always to unusual and needless losses, from the fact that in practically every herd where no record has been kept there will be found a relatively large per cent. of the cows that are not paying for the feed they consume. While the herd as a whole may pay a profit this profit will come from a few cows in the herd, and the other animals will either barely pay for their keep, or will consume some of the profit from the better animals. The majority of the herds in the State have individuals that could be sold for beef, and leave a herd that would pay a greater profit on the food consumed, though with a smaller number of animals. This has been the history of every herd where a system of herd records has been introduced. The writer has yet to hear of a solitary case where the owners have adopted such a system, and have not found cows that they were keeping at a loss.

There are so many ways that suspicion may be allayed as to the true value of a cow. For instance, many dairymen think that because an animal has a strong strain of Jersey, or other dairy blood, they are almost of necessity profitable dairy animals. The truth is that many of the most worthless animals from a dairy, or any other standpoint, are found among the full-blooded animals of all dairy breeds. We have had at this Station a number of Jersey cows that would not pay for the feed they consumed, while in the next stalls stood cows that were of common or scrub blood, and on the same feed paid exceedingly well. It is naturally supposed that the daughters of a good mother should be profitable animals, especially if the sire is of good blood. The Jerseys just mentioned as belonging to this Station were, in two instances, from a cow that would make nearly 400 pounds of butter a

year, and the sire was from very good stock. In one of the counties of this State is a herd of grade Jerseys that will average very nearly 350 pounds of butter each year. Pedigreed Jersey bulls of good stock have always been used at the head of this herd, and yet, until the bull now owned on the farm was purchased, every heifer raised was found to be unprofitable. This is one of the farms in the State where a complete system of records is kept, and by weeding out the inferior animals, the herd was made very profitable, and was kept so.

Another chance for error in estimating the value of a cow is due to the fact that individuals vary considerably in the length of the lactation period. The cow that will give only twenty pounds of milk a day when she is fresh would be considered a rather poor cow, but if she will give this amount every day for 300 days it would be a total of 6,000 pounds, which is an amount that not one dairy cow in twenty in this State will produce, and which is a very good record, indeed. On the other hand, if a cow gave forty pounds a day when she was fresh the owner would naturally jump at the conclusion that she was a valuable animal without reference to the length of time she might give milk. The fact that a cow gives a large quantity of milk when fresh is no evidence that she will give a large yearly product. Such cows frequently commence to fall off very rapidly after the end of the first or second month, and at the end of the sixth month will be dry. Where this is the case the yearly product is very likely to be below a profitable limit. This Station owned such a cow in No. 4, given in subsequent tables. She gave a very large flow of milk for the first month, and made an exceptionally good butter record for the month, but she was dry at the end of six months, and her yearly record, owing to this fact, showed very poorly. She was the only cow owned by the Station, and purchased from outside sources, which failed to respond to our conditions and make a profitable animal. And yet she was just such a cow as many dairymen would call a first-class animal. On the other hand the Station owns a couple of animals that will give practically as much milk the tenth month of the lactation period as the first month, and while they never give a very large flow of milk, the fact that they stick to it for a long time makes them valuable.

But in addition to the keeping of a milk record the dairyman must know the per cent. of fat in the milk, as well as how much milk the cow produces. Everyone who has taken care of milk in the old-fashioned way knows by the thickness of the cream that some cows give much richer milk than others. The best city dairymen are adopting the system of paying for the milk on the basis of the fat test, or the amount of fat contained in the milk. Creameries have long bought milk on this basis. The amount of butter that a certain quantity of milk will produce depends entirely on the per cent. of fat in the milk. Where only one or two cows are kept for family use it is possible to tell about how much butter a cow produces. But with a dairy of several cows, and where the milk is sold, it is impossible to tell which cow is producing rich milk, and which poor milk. Some men think that they can tell by the appearance of milk whether or not it is rich or poor in butter fat. Within wide limits this is so; but the yellowish color often

attributed to the quality of the milk is more often due to the color of the butter fat. The Guernsey breed is famous for the yellow butter it produces. The yellow fat in Guernsey butter gives a decidedly yellowish cast to the milk, and it may well happen that the milk from a Guernsey cow containing only four per cent. of fat may look richer than the milk from some other breed containing six per cent. of fat. What is true of breeds is also true of individuals, and it is impossible to form a very close estimate of the richness of the milk by its appearance.

Cows vary in their fat test from a little less than three per cent. to a little more than six per cent. A cow giving 6,000 pounds of three-per cent. milk is no better than a cow giving but 3,000 pounds per year, but testing six per cent, and neither is worth keeping. Taking the fact of the variation in the per cent. of fat in the milk in connection with the variation in the amount of milk produced, and the dairy farmer has a problem concerning the actual value of the cow in question that cannot be solved without some systematic work. When neither the amount of milk, nor the per cent. of fat, is known, the cow is an extremely suspicious character. How this works out in practice has been demonstrated at this Station, and could likely find good illustrations in every herd in the State. One cow owned by the Station never gave more than about fifteen pounds in any one day of her life, but she gave practically the same amount every day in the year, and as this milk gave an average yearly test of more than six per cent. it can be figured that she paid for her board, with considerable to spare. On the other hand, the cow No. 4, already mentioned, gave a large quantity of milk to start with, but went off in her milk very quickly, and at the same time tested below four per cent. Between these two extremes are all sorts of variations and combinations that make it impossible to make an approximate guess at the value of a cow. In view of these facts, what a simple business proposition it is to know what each cow is doing for her owner, and thus prevent any possibility of loss!

Did the keeping of herd records involve any great amount of expense or labor some excuse might be offered for not undertaking the task; but such is not the case. The actual labor required is very little; in fact, is hardly worth mentioning, considering the results to be obtained. It is very doubtful if there be a herd of cows in Maryland where records are not already kept, where the following of this plan will not, in a single year, pay many times over for all the apparatus and time required by indicating cows that are not paying for their feed.

### KEEPING MILK RECORDS.

The necessary apparatus for keeping a milk record of the amount of milk produced by a cow is a scales for weighing the milk and a ruled sheet of paper on which to enter the weights of the single milkings, called a milk sheet.

There are a number of kinds of scales and balances used. A popular kind has a small platform on which to set the bucket of milk, and the weight is indicated on a dial. An ordinary platform scales of small size, and balanced to the weight of the bucket, so that the weight

of the milk can be determined directly, may be used for this purpose, though it has its disadvantages in the fact that it would take some time to determine the weight, while a balance with a dial points directly to the weight. A kind that has been advertised extensively has an ordinary coil spring, such as is found in the common spring balances. A sheet of paper containing the numbers of the cows each in a separate column is placed in a holder attached to the scales. The bucket containing the milk is placed on a hook, and this pulls down a row of buttons and points corresponding to the numbers of the cows. The button is pressed, and this perforates the paper at the weight of the milk in the bucket. The writer has seen a number of these in use, but has never yet seen one that did satisfactory work.



The balance in use at this Station, a cut of which is here given, is a regular spring balance, with a dial graduated to tenth pounds. The hand in the dial can be adjusted so that the weight of the bucket will point the hand to the zero mark. This allows a direct reading of the weight of the milk. As all buckets used weigh the same the work involved in weighing is very small; in fact, is simply a question of seconds. The balance hangs on a hook which projects far enough from the wall to allow the bucket to swing freely, and is placed handy for the milker. The milk sheet is on the wall by the side of the balance. A man accustomed to this work, and with a fair amount of intelligence, will do the entire operation in a few seconds. The requisites of a good scales are that it weigh accurately, and be sensitive to tenth pounds, that it be simple to handle, and that it require as little time as possible for the weighing. The plat-

form scales, with a dial and adjustable hands, and the balance used at this Station fills these requirements, and are to be recommended. Some scales used are graduated to ounces, but this causes a great amount of extra and useless work in adding records without any compensating advantages.

The method for keeping an exact record of the amount of milk produced by a cow is to weigh the milk at each milking for the entire lactation period, and enter the amount on a monthly milk sheet. Such a milk sheet will require a separate column for each cow, and will require a blank space in the column for each milking for a month.

The following is the style for such a sheet:



The foregoing record can be extended to take in as many cows as desired. It will be found, however, that when more than about fifteen are provided for on one sheet it becomes rather unwieldy in size. It will, of course, be recognized that instead of having the cows numbered the name of the animal can be entered at the head of the column. It is quite necessary in keeping any system of records that the milk be weighed both morning and evening, as on the great majority of farms the periods between milkings are very unequal, thus making the quantities given at the two milkings unequal. Even where the periods are equal the cow will seldom give exactly the same quantity at the two milkings. Were the milk to be weighed but once a day there would be a tendency to weigh at the milking that the largest quantity was given. Farmers are prone to cheat themselves in this way, and this is a case where cheating is likely to result in an actual loss of dollars.

The sample monthly record given would require a new sheet every month, and some provision should be made for copying and preserving the totals, so that in case the daily record was lost the figures of the total yield would be preserved. In fact, there are few conditions, except at Experiment Stations, where it would be desirable to preserve the monthly milk sheets, as the monthly total would show all that any farmer would care to know or refer to.

There are a number of ways in which the monthly totals can be preserved. The regular herd books on the market for this purpose devote two pages to each individual, giving sufficient space for all data in regard to the animal for a number of years. On the first page is a blank form, on which to enter the detailed pedigree of the cow. Below this form is an elaborate scheme for entering the date of breeding, calculated date of calving, actual date of calving, sex of calf, and a column to note the final disposition of the calf. On the record page is a number of blank forms, each for one year, and containing separate columns for the monthly yield of milk, monthly fat test, butter fat and estimated yield of butter. These herd books are very nice for one who feels that he can stand the expense; but there is a great deal of space that would not be used for an ordinary dairy herd, and a blank book, containing enough space for all the necessary data for a number of years could be purchased for fifty cents, at the most. This book could be ruled off to suit the desires of the owner.

The following is given as a satisfactory scheme for keeping yearly records:

## Herd Record for Year of 190

[illegible]

The sample yearly record is not given as the best possible, or even suitable for all conditions; but it does show how simple such a record can be, and how easily it can be placed in a blank book of almost any description. The necessary ruling for a large herd can be done in an hour's time.

In the sample given it is intended that all of the cows be placed together on the same or adjoining pages for the same year. The record for each cow is supposed to commence the month that she drops her calf, and it is not at all necessary that the first blank space in each record be filled with the product of January, or any other particular month of the year. Thus, for instance, if the year is 1904, Cow No. 1 may drop her calf in March, and the record could commence in the first blank space at the top of the column, giving March as the month. Cow No. 2 may not drop her calf until August, and this month would be entered in the first blank space at the top of the column, putting the month of August parallel with March, in the record of Cow No. 1. Instead of having the yearly record a record of the performance of each cow from January 1st to December 31st, it is, in reality, the record for a full lactation period of every cow that drops her calf in the year given at the head of the page. A good number of the records will necessarily extend into the following year. In this blank space is allowed for twelve months only. There isn't any doubt but that this will suffice for most cows, and as dairy cows are supposed to drop calves every twelve months at least, this is the length of time on which the value of the animal should be calculated. If the cow ran over the twelve months, as some will when they fail to get with calf, the record should be continued into the next year, making note of the fact at the head of the column. The column headed "test" will be explained later, and another column could be added for the butter fat, or estimated butter, when the herd is tested every month of the lactation period.

Some dairymen naturally want a scheme for keeping track of the amount of milk produced by a cow without some work—one that will not require so much time and trouble, as where the milk is weighed and recorded every night and morning. A very satisfactory and fairly accurate substitute for this method can be found in weighing the milk once a week, or rather one day in the week, night and morning, Saturday or Monday being the day that will be usually selected, for obvious reasons. By getting the sum of the quantities of milk given every weigh day for the year, and multiplying by seven, the number of days in the week, the amount will be sufficiently accurate for all practical purposes in estimating the value of the cow. This scheme for keeping records is to be recommended to dairymen who feel that for different reasons the weighing of the milk every night and morning in the year is impractical, and there are doubtless many for whom this is true. The blanks to be used for weekly weighings will necessarily be somewhat different from the monthly milk sheets, as no monthly record will be practical with this system.

Two methods by which the records of the weekly weighings could be kept are available. In one a milk sheet, much like the one used in making daily weighings, could be employed. This sheet could be

headed so as to give the date of the first weighing and last weighing entered on the sheet. In the date column of the monthly milk sheet the figures should be left out, and more space would be necessarily needed for the month and date of the weekly weighing to be entered. The A. M. and P. M. would need to remain as given. This form of sheet could be extended to cover as many cows, and as many weeks, as desired; but there are two difficulties standing in the road of extending this over too many weighings. One is that a milk sheet becomes filthy and illegible from too long use. The other difficulty applies to the monthly sheet, as well as the long weekly sheet. Where such a long column of figures are to be added it requires a practiced hand to do the work correctly, though it appears a very simple proposition. In the case of the monthly record the mistake might not be serious, but were this mistake to be multiplied by seven, as would be the case with the weekly weighings, the mistake would likely become a very serious matter. For these various reasons it would likely be better to limit the weekly milk sheets to ten weeks at the most.

Where the sheets for weekly weighings are intended for an indefinite time it would be necessary that each one be preserved until the end of the lactation periods, when the totals could be added up, or the totals of each one, as it was added, could be placed in a yearly record book for this purpose. This record book should give space in its date column for entering the dates of the first and last weighings entered on the sheet.

Another and desirable method of keeping a permanent record of the weekly weighings would be to divide the year into thirteen periods of four weeks each. This would make it possible to have the milk sheets made for only eight weighings each. In this case the milk sheets would be about as follows:



The foregoing blank explains itself and can be extended to include as many cows as desired. The heading should give the dates of the first and last milkings entered on the sheet, and in the date column the month and day of the month on which each milking is done should be entered.

To meet the foregoing arrangement the yearly record book could be substantially the same as the yearly record book when daily weighings are entered on a monthly milk sheet. The record could be ruled for thirteen, instead of twelve, months, and the date column should give space to enter the dates of the first and last weighings in each division. This division of the year into four weeks periods has no disadvantages, except that it is a little different from the customary method of dividing the year, and might, perhaps, lead to a little confusion of the mind in consequence. In some ways, where comparative records are kept, as in feeding experiments conducted at Experiment Stations, this division would have a decided advantage, as the periods would be of equal length, which they are not in the arbitrary twelve month division, and would admit of comparison of yields.

In the style and expense of the milk sheets to be used in any of the methods given there is room for choice. The monthly sheets can be secured already printed from some of the dairy supply houses, or can be ordered in any style desired from some of the larger job printing firms. For the ordinary dairyman the milk sheets are fully as good when home-made as when purchased, and much less expensive. For this purpose heavy wrapping paper, of light color, can be used. With a rule, or a straight edge of any sort, and a lead pencil, any man can make a milk sheet that will serve every purpose. If it is desired to preserve the monthly sheets a good quality of glazed paper should be used. The book in which to enter the monthly totals should be substantial, as most dairymen having once started to keeping records would like to preserve the totals for the gratification that watching one's herd improve will give to any thoughtful and business-like man. To a man once started in this work there is a real pleasure, especially in seeing what heifers from favorite cows will do, and in testing one's judgment of cows on their appearance. It is safe to say that a man who tests cows is a better judge of dairy cows in every way than one who does not.

## TESTING MILK FOR BUTTER FAT.

As has been said, to get an accurate knowledge of a cow's value as a dairy animal, it is necessary to know the amount of butter fat that she produces, as well as the amount of milk. It was pointed out that a cow might give a large quantity of milk, and yet be unprofitable, owing to the small per cent. of butter fat that the milk contained.

It has been only within comparatively recent years that an accurate, simple and inexpensive fat test has been known. Every dairyman

has heard of the Babcock test, and within the last few years a number of different styles of this machine have been placed on the market, at a price within the reach of all. In fact, the cost of and expense of operating these is so little, and the time required is so short, that practically every dairyman should own and make use of one of these machines; or, what might be better, a few farmers could combine and get a Babcock test, and thus save some of the expense. This would be entirely practical, as each farmer would not care to use the machine oftener than one day in the month. As is the case with keeping a record of the amount of milk given by each cow in the herd, the making of a fat test is a simple business proposition of the most practical kind, and as far removed from so-called theory as it is possible to be. It is impossible to tell what per cent. of fat the milk from a cow contains, without testing it. The value of the cow depends on the amount of butter fat she produces. The milk can be weighed, but the butter fat cannot be weighed; it must be determined by testing, and so why not test and know if the cow is paying for herself?

It is not intended in this connection to enter into any detailed discussion of the manipulation of the Babcock test. It is rather the intention to tell when and how often it is necessary to test for practical purposes.

The only absolutely accurate way to tell the amount of butter fat produced by each cow is to test the milk from every milking. Cows may vary so much in the per cent. of fat in the milk from one milking to another, or from one day to another, owing to unnatural, but for the most part uncontrollable causes, that it is impossible to make a test of the milk from one milking, and be able to say that it will represent fairly the per cent. of fat in the milk for the entire milking period, or for even one month. But while this may be so, it is a fact that from one week to another a cow tests practically the same, varying usually in a gradual manner as the lactation period advances. But this gradual variation is so different in different cows that it is impossible, without looking into the matter, to settle on any one month that will furnish a test near enough to the actual average for practical purposes. A test made indiscriminately in any month of the lactation period is likely to prove very misleading.

Of course, it is obvious that to test a cow at every milking of her lactation period would be far too much work to pay any but investigators, and then only when the most accurate results were desired. To test once a week from what is called a composite sample (to be explained later) is more work than most Experiment Stations care to undertake. A great many Experiment Stations test once every two weeks, or twice a month, from a composite sample collected from all of the milkings from three days to a week. Other Stations test every month from a composite sample of all of the milkings for a week. Very few dairy farmers would care to test even this often, and it is the object of this portion of the bulletin to point out some plan whereby two or three tests of the milk from a cow in a year, or lactation period, will give fairly accurately the average test for the entire lactation period.

To get at this question in a systematic manner a table has been prepared giving the test by months, with the average yearly test of the cows owned by this Station. This table covers every lactation period of every cow owned by the Station where the milking period was not extended beyond twelve months by reason of the cow failing to get with calf, or where the lactation period was not interfered with, owing to abortion. It contains old and young, good and unprofitable cows.

## SYSTEMS FOR KEEPING MILK AND BUTTER RECORDS.

15

| Cow No. | Year. | Test<br>1st<br>Cow | Test<br>2nd<br>Cow | Test<br>3rd<br>Cow | Test<br>4th<br>Cow | Test<br>5th<br>Cow | Test<br>6th<br>Cow | Test<br>7th<br>Cow | Test<br>8th<br>Cow | Test<br>9th<br>Cow | Test<br>10th<br>Cow | Test<br>11th<br>Cow | Test<br>12th<br>Cow | Average<br>Test<br>Per<br>Year |
|---------|-------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|---------------------|---------------------|--------------------------------|
| 1       | '99   | 4.1%               | 4.8%               | 5.0%               | 5.4%               | 5.5%               | 5.9%               | 5.6%               | 5.2%               | 5.3%               | 5.0%                | 4.8%                | 6.0%                | 5.3%                           |
|         | '00   | 5.0                | 4.9                | 5.0                | 5.5                | 5.2                | 4.9                | 5.0                | 5.2                | 5.2                | 6.5                 | .....               | .....               | 5.2                            |
|         | '01   | 4.7                | 4.7                | 4.6                | 4.8                | 4.6                | 5.0                | 4.8                | 4.8                | 4.8                | 4.5                 | .....               | .....               | 4.7                            |
| 4       | '96   | 3.3                | 3.5                | 3.8                | 3.6                | 3.7                | 3.6                | 3.1                | 3.3                | 3.6                | 4.2                 | .....               | .....               | 3.5                            |
|         | '97   | 3.4                | 3.8                | 3.4                | 3.9                | 4.2                | 3.4                | 4.0                | .....              | .....              | .....               | .....               | .....               | 3.7                            |
| 7       | '97   | 4.1                | 3.6                | 4.3                | 4.0                | 5.0                | 5.0                | 4.8                | 6.0                | 5.7                | 6.0                 | .....               | .....               | 4.6                            |
|         | '00   | 5.0                | 5.5                | 6.0                | 5.4                | 5.9                | 5.1                | 6.0                | 5.5                | 6.0                | 5.1                 | 5.5                 | 6.8                 | 5.5                            |
| 15      | '97   | 4.0                | 3.0                | 4.0                | 3.9                | 4.3                | 4.0                | 4.3                | 4.3                | 4.0                | .....               | .....               | .....               | 3.9                            |
|         | '98   | 3.0                | 3.2                | 3.8                | 4.4                | 3.9                | 3.8                | 3.8                | 3.9                | 4.7                | 4.3                 | 4.4                 | 4.6                 | 3.9                            |
|         | '01   | 3.8                | 4.3                | 4.0                | 4.0                | 3.9                | 4.2                | 4.2                | 4.4                | 4.4                | 3.6                 | 4.2                 | 4.0                 | 4.1                            |
| 16      | '96   | 4.6                | 4.8                | 4.6                | 4.6                | 4.6                | 4.0                | 3.9                | 4.1                | 4.0                | 3.5                 | 4.5                 | 4.2                 | 4.3                            |
|         | '97   | 4.3                | 4.2                | 4.6                | 5.0                | 4.7                | 4.8                | 4.2                | 4.8                | 4.6                | 5.0                 | 4.8                 | 4.6                 | 4.6                            |
| 17      | '96   | 5.9                | 4.5                | 4.4                | 4.0                | 4.2                | 4.7                | 4.2                | 3.3                | 3.9                | 3.2                 | 3.2                 | .....               | 4.1                            |
|         | '97   | 4.3                | 4.0                | 4.6                | 4.7                | 4.2                | 5.0                | 4.8                | 4.6                | .....              | .....               | .....               | .....               | 4.5                            |
|         | '98   | 4.0                | 4.5                | 4.2                | 4.0                | 4.3                | 4.2                | 4.9                | 5.0                | 4.5                | 4.8                 | 5.2                 | .....               | 4.4                            |
|         | '99   | 4.7                | 4.5                | 4.4                | 4.8                | 4.8                | 4.7                | 4.8                | 4.6                | 4.8                | .....               | .....               | .....               | 4.7                            |
| 19      | '96   | 4.9                | 4.5                | 4.8                | 4.8                | 4.2                | 4.5                | 4.3                | 4.1                | 3.9                | 4.8                 | .....               | .....               | 4.4                            |
|         | '97   | 4.5                | 4.9                | 5.0                | 4.8                | 4.6                | 6.0                | 4.6                | 4.6                | 5.0                | .....               | .....               | .....               | 4.9                            |
|         | '98   | 4.2                | 4.4                | 5.0                | 4.7                | 4.2                | 4.9                | 5.4                | 5.0                | 4.8                | 5.0                 | 6.1                 | .....               | 4.8                            |
| 23      | '99   | 4.2                | 4.4                | 4.6                | 4.5                | 4.4                | 4.9                | 5.0                | 5.1                | 5.3                | 4.7                 | 5.6                 | .....               | 4.7                            |
|         | '00   | 5.0                | 4.3                | 4.8                | 5.0                | 5.0                | 5.0                | 5.1                | 5.0                | 5.1                | 5.3                 | 5.0                 | .....               | 5.0                            |
|         | '01   | 4.8                | 4.2                | 4.2                | 4.7                | 4.6                | 4.5                | 5.0                | 4.6                | 4.9                | 5.0                 | 5.0                 | .....               | 4.6                            |
| 25      | '99   | 4.2                | 4.5                | 4.5                | 4.5                | 5.0                | 4.6                | 4.7                | 4.6                | 5.1                | 4.6                 | 5.5                 | 5.6                 | 4.7                            |
|         | '00   | 5.5                | 5.0                | 4.6                | 5.0                | 4.6                | 4.5                | 5.0                | 4.6                | 5.4                | .....               | .....               | .....               | 4.8                            |
|         | '01   | 4.7                | 4.8                | 4.6                | 4.7                | 4.4                | 4.6                | 5.2                | 5.1                | 4.4                | .....               | .....               | .....               | 4.7                            |
| 26      | '99   | 4.7                | 4.2                | 4.8                | 4.5                | 4.9                | 4.5                | 4.6                | 4.4                | 4.8                | 4.7                 | .....               | .....               | 4.6                            |
|         | '00   | 4.0                | 4.2                | 4.1                | 3.6                | 4.0                | 4.0                | 4.5                | 4.1                | 4.2                | 4.6                 | 5.0                 | .....               | 4.1                            |
|         | '01   | 4.4                | 4.5                | 4.6                | 4.3                | 4.2                | 4.0                | 3.8                | 4.0                | 4.2                | 4.7                 | .....               | .....               | 4.3                            |
| 27      | '99   | 4.1                | 4.8                | 5.3                | 5.4                | 5.2                | 4.9                | 5.2                | 5.2                | 5.8                | 6.1                 | 6.1                 | .....               | 5.2                            |
|         | '00   | 5.4                | 5.3                | 5.5                | 4.9                | 5.3                | 5.5                | 4.5                | 5.5                | 6.3                | 6.5                 | .....               | .....               | 5.3                            |
|         | '01   | 5.0                | 4.8                | 5.2                | 4.9                | 4.8                | 4.7                | 4.6                | 5.2                | 5.2                | 5.4                 | .....               | .....               | 5.0                            |
| 28      | '97   | 3.8                | 3.7                | 3.6                | 4.0                | 3.9                | 4.3                | 4.3                | 4.0                | 4.4                | 4.2                 | .....               | .....               | 4.0                            |
|         | '00   | 4.5                | 4.4                | 4.1                | 4.3                | 4.4                | 3.8                | 3.8                | 4.2                | 4.0                | 4.0                 | 4.2                 | .....               | 4.2                            |
|         | '01   | 4.0                | 3.9                | 3.8                | 3.6                | 3.8                | 3.8                | 4.0                | 3.6                | 4.2                | .....               | .....               | .....               | 3.9                            |
| 29      | '97   | 5.0                | 4.6                | 4.2                | 5.0                | 4.8                | 5.2                | 5.0                | 5.4                | 5.4                | .....               | .....               | .....               | 4.9                            |
|         | '00   | 4.5                | 4.9                | 5.0                | 5.2                | 5.5                | 5.6                | 4.7                | 4.1                | 5.2                | 4.9                 | 5.0                 | .....               | 5.0                            |
| 31      | '00   | 4.7                | 5.0                | 5.0                | 4.6                | 4.5                | 4.9                | 5.3                | 5.4                | .....              | .....               | .....               | .....               | 4.9                            |
|         | '01   | 4.6                | 3.7                | 4.1                | 4.5                | 4.4                | 4.5                | 4.8                | 5.0                | 5.1                | 5.7                 | 6.2                 | .....               | 4.5                            |
| 32      | '00   | 6.0                | 5.3                | 4.8                | 4.2                | 5.0                | 4.8                | 5.9                | 5.8                | 6.6                | 7.4                 | 6.8                 | .....               | 5.5                            |
|         | '01   | 7.0                | 6.1                | 5.3                | 4.9                | 6.0                | 4.5                | 4.4                | 6.0                | 6.0                | 6.0                 | 6.1                 | .....               | 5.4                            |
|         | '02   | 6.0                | 5.4                | 4.6                | 4.3                | 4.5                | 4.8                | 5.3                | 5.5                | 6.1                | 6.2                 | .....               | .....               | 5.2                            |
| 33      | '00   | 6.5                | 6.7                | 6.7                | 6.6                | 6.0                | 6.0                | 6.0                | 6.3                | 5.6                | 7.0                 | .....               | .....               | 6.4                            |
| 35      | '00   | 4.0                | 4.3                | 4.8                | 5.0                | 5.0                | 5.2                | 5.1                | 4.9                | 5.3                | 6.0                 | 4.8                 | 5.7                 | 5.1                            |
|         | '01   | 5.3                | 4.7                | 4.7                | 4.7                | 4.2                | 4.6                | 4.6                | 5.0                | 4.7                | 5.7                 | .....               | .....               | 4.7                            |
|         | '02   | 4.8                | 4.7                | 4.4                | 4.6                | 4.6                | 4.8                | 4.0                | 4.6                | 5.4                | .....               | .....               | .....               | 4.6                            |
| 36      | '01   | 5.3                | 5.5                | 5.7                | 5.6                | 4.9                | 5.4                | 5.8                | 6.3                | 6.0                | 5.7                 | 6.1                 | .....               | 5.7                            |
|         | '02   | 5.5                | 4.9                | 5.6                | 6.7                | 6.0                | 5.4                | 5.3                | 5.0                | 5.0                | 5.1                 | 5.4                 | 6.8                 | 5.6                            |
| 37      | '00   | 4.7                | 5.5                | 5.5                | 5.5                | 5.8                | 6.1                | 5.4                | 6.6                | 6.8                | 5.2                 | 5.2                 | .....               | 5.7                            |
|         | '01   | 5.7                | 5.4                | 5.3                | 5.6                | 5.8                | 5.2                | 5.7                | 4.9                | 5.5                | 5.2                 | 5.0                 | .....               | 5.4                            |
|         | '02   | 5.2                | 5.9                | 5.4                | 5.8                | 5.6                | 5.6                | 5.6                | 5.2                | .....              | .....               | .....               | .....               | 5.5                            |
| 39      | '01   | 4.9                | 5.0                | 4.8                | 5.0                | 5.2                | 5.0                | 4.8                | 5.7                | 4.9                | .....               | .....               | .....               | 5.1                            |
|         | '02   | 4.8                | 4.8                | 4.9                | 5.0                | 5.1                | 5.1                | 4.8                | 5.0                | 5.5                | .....               | .....               | .....               | 4.9                            |
| 47      | '01   | 4.9                | 5.2                | 5.4                | 5.3                | 5.1                | 4.6                | 5.6                | 5.6                | 5.0                | 5.0                 | 6.1                 | .....               | 5.2                            |
| 58      | '01   | 5.8                | 4.4                | 4.6                | 4.5                | 4.6                | 4.8                | 4.8                | 4.8                | .....              | .....               | .....               | .....               | 4.9                            |
|         | '02   | 4.3                | 4.4                | 4.6                | 4.8                | 4.9                | 4.8                | 5.0                | 4.4                | 5.0                | .....               | .....               | .....               | 4.6                            |

Two or three general principles have been advanced, covering the natural variations in a fat test of a single cow from one period to another. With many cows the milk is very likely to show a very high comparative test from two to four weeks after the beginning of the lactation period. Though this general statement cannot be made of all, or even a large majority of cows, as many cows give the very smallest per cent. of fat in the milk immediately after ceasing to give colostrum milk. From this on the test will remain practically the same for a few months. Cows nearly always increase in the fat test very gradually after the first three or four months of the lactation period. A fresh cow, after the first month of her milking period, may test as low as four per cent. of fat, and the last two or three months of the lactation period will test as high as six per cent., or even more, in some cases. This is a rather unusual variation, but it will occur occasionally.

Feed will not affect the fat test, except for a very short period of time, and it is useless to try and change a low testing cow to a high testing animal by giving better feed or more feed. This is a hard and fast principle that many dairymen find very difficult to believe. Cows turned suddenly from dry winter feed to early green pasture increase the milk flow, and for a very short while only the per cent. of fat will be lowered. In a couple of weeks the fat test will be back to normal, though the increased milk flow will continue, or may be even augmented in the same period.

With these principles established it is the desire to see if some rule may be formulated as to the proper time to get approximately an average test when testing from one to three times during the lactation period. The rest of the bulletin will be given up to a consideration of the facts in connection with this idea.

The first to be determined is whether any particular month or months in the lactation period can be pointed out as furnishing a test that will be approximately near the actual average yearly test. A few points are obvious. The first month, owing to the fact that some cows test very high, and some very low, cannot be considered in this connection. As cows gradually increase in their test from the first to the last of the lactation period, the second and third months would furnish too low a test, while the last three months of the lactation period would be likely to furnish too high a test. By a combination of these months, or by selecting a time near the middle of the lactation period, one should be able to come near an average test.

To facilitate this work a table has been prepared, based on the previous table, giving the monthly and yearly tests of the Station herd. As its heading shows, it gives the variation of the monthly tests from the average yearly test. The plus sign is used when the monthly test is more than the average yearly test, and the minus sign when it is less. The average given at the bottom of the table is the average variation for the month of all the cows in every year. Though it was impossible to make the table appear other than formidable, owing to its size and

the number of figures necessary to present, on inspection it is easy to understand. For instance, the average test of the cow No. 1 for the year '99 was 5.3 per cent. In the second month of the lactation period the test was .5 per cent. less than the average yearly test; in the third month it was .3 per cent. less; in the fourth month it was .1 per cent. more, and so on through the table. The average at the bottom of each monthly column was determined by adding the plus and minus quantities each separately, subtracting and dividing by the total number of lactation periods considered.

*Per Cent. of Variation From Average Yearly Tests.*

| Cow No.  | Year. | 2nd Month. | 3rd Month. | 4th Month. | 5th Month. | 6th Month. | 7th Month. | 8th Month. | 9th Month. | Average 3rd and 8th Months. | Average 4th and 7th Months. | Average 2nd and 8th Months. | Average 2nd, 5th and 9th Months. | Average 3rd, 6th and 8th Months. |
|----------|-------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------------------|-----------------------------|-----------------------------|----------------------------------|----------------------------------|
| 1        | '99   | -.5        | -.3        | +.1        | -.2        | -.6        | -.3        | -.1        | 0          | -.1                         | +.2                         | -2.5                        | -.1                              | -.1                              |
|          | '00   | -.3        | -.2        | +.3        | 0          | -.3        | -.2        | 0          | 0          | -.1                         | 15.                         | -.15                        | -.1                              | +0.1                             |
|          | '01   | 0          | -.1        | 1          | -.1        | -.3        | 1          | 1          | 1          | 0                           | 1                           | +.05                        | 0                                | +2                               |
| 4        | '96   | 0          | -.3        | 1          | 2          | 1          | 4          | 2          | 1          | +.05                        | -.15                        | +.05                        | 1                                | +0                               |
|          | '97   | +.1        | -.3        | 2          | 5          | -.3        | 3          |            |            | 0                           | 25                          | +.05                        | 2                                | +0                               |
| 7        | '97   | -1.0       | -.3        | 6          | 4          | 4          | 2          | 1.4        | 1.1        | 55                          | 20                          | +.05                        | 2                                | +4                               |
|          | '00   | 0          | 5          | 1          | 4          | 4          | 5          | 0          | 5          | 25                          | 2                           | 25                          | 3                                | +1                               |
| 15       | '97   | -.9        | 1          | 0          | 4          | 1          | 4          | 3          | 1          | 2                           | 2                           | 4                           | 1                                | +1                               |
|          | '98   | -.7        | 1          | 5          | 0          | 1          | 1          | 0          | 8          | +.05                        | 2                           | +.05                        | 0                                | +1                               |
|          | '01   | +.2        | 1          | 1          | 2          | 1          | 1          | 3          | 3          | 1                           | 0                           | +.25                        | 1                                | +1                               |
| 16       | '96   | +.5        | +.3        | +.3        | 3          | 3          | 4          | 2          | 3          | +.05                        | +.05                        | 1                           | 2                                | 1                                |
|          | '97   | -.4        | 0          | 4          | 1          | 2          | 4          | 2          | 0          | 1                           | 0                           | 2                           | 1                                | +1                               |
|          | '96   | -.4        | 3          | 1          | 1          | 6          | 1          | 8          | 2          | 25                          | 1                           | 1                           | 1                                | +1                               |
| 17       | '97   | -.5        | 1          | 2          | 3          | 5          | 2          | 1          | 1          | 1                           | 2.5                         | -.25                        | 4                                | +3                               |
|          | '98   | +.1        | 2          | 4          | 1          | 2          | 5          | 6          | 1          | 2                           | +.05                        | 1                           | 0                                | +0                               |
|          | '99   | 2          | 3          | 1          | 1          | 0          | 1          | 1          | 1          | 2                           | 1                           | 15                          | 4                                | +0                               |
| 19       | '96   | 1          | 4          | 4          | 2          | 1          | 1          | 3          | 5          | +.05                        | 15                          | 2                           | 2                                | +1                               |
|          | '97   | 0          | 1          | 1          | 3          | 1.1        | 3          | 3          | 1          | 1                           | 2                           | +.05                        | 1                                | +2                               |
|          | '98   | -.4        | 2          | 1          | 6          | 1          | 6          | 2          | 0          | 2                           | 2.5                         | 2                           | 3                                | +1                               |
| 23       | '99   | -.3        | 1          | 3          | 3          | 2          | 3          | 4          | 5          | 15                          | 0                           | 1                           | 0                                | +1                               |
|          | '00   | -.2        | 2          | 0          | 0          | 0          | 1          | 0          | 1          | 1                           | +.05                        | 3                           | 2                                | +0                               |
|          | '01   | -.4        | 4          | 0          | 0          | 0          | 4          | 0          | 3          | 2                           | 2                           | +.05                        | 0                                | +0                               |
| 25       | '99   | -.2        | 2          | 2          | 3          | 1          | 0          | 1          | 4          | 1.5                         | 1                           | 1                           | 2                                | 1                                |
|          | '00   | 2          | 2          | 2          | 2          | 3          | 2          | 2          | 6          | 2                           | 2                           | 3                           | 2                                | 1                                |
|          | '01   | 1          | 1          | 0          | 3          | 1          | 5          | 4          | 3          | 15                          | 25                          | 2                           | 0                                | +1                               |
| 26       | '99   | -.4        | 2          | 1          | 3          | 1          | 0          | 2          | 2          | 0                           | +.05                        | 1                           | 0                                | 1                                |
|          | '00   | 1          | 0          | 5          | 1          | 1          | 4          | 0          | 1          | 0                           | +.05                        | 1                           | 0                                | 2                                |
|          | '01   | 2          | 3          | 0          | 1          | 3          | 5          | 3          | 1          | 0                           | 25                          | +.05                        | 0                                | 2                                |
| 27       | '98   | -.4        | 1          | 2          | 0          | 3          | 0          | 0          | 6          | +.05                        | 1                           | 1                           | 1                                | +0                               |
|          | '00   | 0          | 2          | 4          | 0          | 2          | 8          | 2          | 1.0        | 2                           | 6                           | 5                           | 3                                | +0                               |
|          | '01   | -.2        | 2          | 1          | 2          | 3          | 4          | 2          | 2          | 2                           | 25                          | 0                           | 1                                | 1                                |
| 28       | '97   | -.3        | 4          | 0          | 1          | 2          | 3          | 0          | 4          | 2                           | 15                          | +.05                        | 0                                | +1                               |
|          | '00   | 2          | 1          | 1          | 2          | 4          | 4          | 0          | 2          | +.05                        | 15                          | 0                           | 0                                | 1                                |
|          | '01   | 0          | 1          | 3          | 1          | 1          | 1          | 3          | 3          | 2                           | 15                          | 15                          | 1                                | 2                                |
| 29       | '97   | -.3        | 7          | 1          | 1          | 3          | 1          | 5          | 5          | 1                           | 1                           | 1                           | 0                                | +3                               |
|          | '00   | -.1        | 0          | 2          | 5          | 6          | 3          | 9          | 2          | 4.5                         | 1.5                         | +.05                        | 2                                | +0                               |
|          | '01   | 1          | 1          | 3          | 4          | 0          | 4          | 5          |            | 3                           | 15                          | +.05                        | 1                                | +1                               |
| 31       | '01   | -.8        | 4          | 0          | 1          | 0          | 3          | 5          | 6          | +.05                        | 15                          | -.1                         | 1                                | +2                               |
|          | '00   | -.2        | 7          | 3          | 5          | 7          | 4          | 3          | 1.1        | 2                           | +.05                        | 4.5                         | 1                                | 2                                |
|          | '01   | 9          | 1          | 5          | 6          | 9          | 1.0        | 6          | 6          | 25                          | 7.5                         | 6.5                         | 6                                | 3                                |
| 32       | '02   | 2          | 6          | 9          | 7          | 4          | 1          | 3          | 9          | 15                          | 4.0                         | 5.5                         | 1                                | 3                                |
|          | '00   | 3          | 3          | 2          | 4          | 4          | 4          | 1          | 8          | 1                           | 1                           | 25                          | 3                                | 1                                |
|          | '00   | 8          | 3          | 1          | 1          | 1          | 0          | 2          | 2          | 25                          | +.05                        | 3                           | 2                                | 1                                |
| 35       | '01   | 0          | 0          | 0          | 5          | 1          | 1          | 3          | 0          | 15                          | +.05                        | 0                           | 2                                | +1                               |
|          | '02   | 1          | 2          | 2          | 0          | 2          | 6          | 0          | 8          | 10                          | 2                           | 4.5                         | 3                                | +1                               |
|          | '01   | 2          | 0          | 1          | 8          | 3          | 1          | 6          | 3          | 3                           | 0                           | +.05                        | 2                                | +1                               |
| 36       | '02   | 7          | 0          | 1.1        | 4          | 2          | 3          | 6          | 6          | 3                           | 4                           | 6.5                         | 3                                | +1                               |
|          | '00   | 2          | 2          | 2          | 1          | 2          | 4          | 3          | 9          | 1.1                         | 35                          | 25                          | 3                                | +4                               |
|          | '01   | 0          | 1          | 2          | 4          | 2          | 3          | 5          | 1          | 3                           | 25                          | +.05                        | 2                                | 2                                |
| 37       | '02   | 4          | 1          | 3          | 1          | 1          | 1          | 3          |            | 2                           | 2                           | 2                           | 2                                | +0                               |
|          | '01   | 1          | 3          | 1          | 1          | 1          | 3          | 6          | 2          | 15                          | 1                           | 15                          | 1                                | +1                               |
|          | '02   | 1          | 0          | 1          | 2          | 2          | 1          | 1          | 6          | +.05                        | 0                           | 25                          | 2                                | +1                               |
| 47       | '01   | 0          | 2          | 1          | 1          | 6          | 4          | 4          | 2          | 3                           | 25                          | 1                           | 1                                | +0                               |
|          | '01   | 5          | 3          | 4          | 3          | 1          | 1          | 1          |            | 2                           | 25                          | 25                          | 4                                | 2                                |
|          | '02   | 2          | 0          | 2          | 3          | 2          | 4          | 2          | 4          | 2                           | 3                           | 1                           | 2                                | +1                               |
| 58       | '01   | 5          | 3          | 4          | 3          | 1          | 1          | 1          |            | 2                           | 25                          | 25                          | 4                                | 2                                |
|          | '02   | 2          | 0          | 2          | 3          | 2          | 4          | 2          | 4          | 2                           | 3                           | 1                           | 2                                | +1                               |
| Ave tag. |       | -.14       | -.06       | +.008      | -.01       | +.008      | +.01       | +.08       | +.2        | +.01                        |                             | +.03                        |                                  |                                  |

A variation of .1 per cent. from the average yearly test would, on a yearly product of 5,000 pounds of milk, cause a miscalculation in the yearly butter produced of about six pounds. A variation of .2 per cent. would cause a miscalculation of about twelve pounds of butter; .3 per cent., eighteen pounds; .4 per cent., twenty-four pounds, and .5 per cent., thirty pounds. Six pounds, more or less, of butter in a yearly yield is a small matter; but when a cow is bordering very closely on the dividing line between profit and loss a miscalculation of thirty pounds one way or the other would likely cause a serious error in judgment. As some allowance has to be made for variation, however, the writer has calculated that a system for testing that can be depended on to give an average within .4 per cent. of the actual yearly average in all, or nearly all, cases is sufficiently accurate for practical purposes.

In starting into a discussion of the figures shown in this table it is desired to emphasize the fact that the monthly tests given are from a composite sample representing the night and morning milks of each cow for from five days to one week. This should represent a very fair test of the cow for that particular portion of her lactation period, some unexpected variations to the contrary notwithstanding. Let us notice some of these variations, for they influence directly the results of our inquiry. With cow No. 19, in the year '97, the tests for the fifth and seventh months were .3 per cent. below the yearly average, while for the sixth month it was 1.1 per cent. above the yearly average. With cow No. 27, in the year '00, the tests for the sixth and eighth months were .2 per cent greater than the yearly average, while for the seventh month it was .8 per cent. below the yearly average. A variation of from .2 to .5 per cent. from one month to another is to be expected, but a variation of 1 per cent. or more is rather unexpected, to say the least. These variations emphasize the fact that a single test is hardly to be depended on. They are due, in part, perhaps, to the fact that some unusual and unknown condition affected the cow for a few days, while the composite sample was being taken. Or, on the other hand, the cow may have been in an entirely normal condition, and the test was a normal one for that period.

The first proposition to be considered is the possibility of one test in a year representing a fair average for the yearly test. Can one test be depended on to give a fair average? If so, what month, or months, in the lactation period can be selected for this test? A glance at the average variations of the monthly tests given, at the bottom of the columns, shows that as far as the averages are concerned any month given, with the exception of the second and ninth, could be selected for the test. But in studying the variation of each animal for each month a slightly more difficult problem is presented. It might be said in passing that if one is to take into consideration the rather unusual variations before noticed a single test of any cow might prove very misleading. But these will be left out of the calculation for the present. The second and ninth months are already excluded, by reason of the average tests being greater than the limit of variation to be allowed. Taking the third month as an example, Nos. 7, 29 and 32 show variations of .5 per cent..

and greater from the average test. This is too large a number. In the fourth month, Nos. 7, 15, 26, 32 and 36 show variations of .5 per cent. or greater. In the fifth month, Nos. 4, 19, 29, 32 and 36 show too great a variation. In the sixth month, Nos. 1, 17, 19, 29, 32 and 47 show variation too great for consideration. The seventh month is not quite so bad, owing to a couple of abnormal tests with cows 32 and 35 it is not much better than the others. A large part of the trouble is due to the individuality of some of the cows in question. No. 32 has been a stumbling block all along. Starting in the second month with a test greater than her yearly average, she fell very much below her yearly average in the third month, and continued low for a seemingly very long period. No. 32 was much too good a cow to leave her record out of calculation, as she would make 60 pounds of butter in a month, and she held to her milk flow with great persistence. Judging from these variations, and considering the case of No. 32, the seventh month would be the best month of the lactation period to test a cow when only one test per year was to be made. It is evident, though, that where a cow came near the line of profit or loss a single test could not be depended on for furnishing an accurate basis for judging her value.

A combination of two tests, taken at different periods, would, of course, be more likely to approach a fair average than could a single test, and an effort has been made to figure out a combination of months that would give a fairly accurate test. In making selection of months the average monthly variation was considered, and combinations of months were selected where the average variations would counterbalance. This was found to be the case with the third and eighth months, with the fourth and seventh months, and very nearly so with the second and eighth months. The results of these combinations are determined by adding the tests for the two months selected, dividing by two and comparing this with the average yearly test, using the plus and minus signs, as with the variations of the monthly tests.

The combination of the third and eighth months shows a variation from the average test of .5 per cent. or greater in the case of cow No. 7, though cow No. 29 is above .4. The combination of the fourth and seventh months shows too great a variation with cows Nos. 27 and 32, owing to an abnormal test with 27, and to the fact that 32 tested below the average in both of the months selected. The combination of the second and eighth months shows a number of serious variations; so many, in fact, as to make it entirely unreliable. Judging from the results of the various combinations, that of the third and eighth months would be the best. When a cow, as is the case with No. 4, does not give milk for eight months, the chances are that she is an unprofitable animal, without reference to the test.

The combinations made for three tests were worked out the same as with those for two tests, using averages that would about balance one with the other. This was found to be the case with the second, fifth and ninth months, and with the third, sixth and eighth months. The first combination shows but one serious variation, and that is entirely due to

an abnormal test with No. 32. The second combination shows no serious variation, and either of these would insure results that could be depended on to give a fair basis for estimating the value of a cow. When testing in the second, fifth and ninth months it might be well to substitute the eighth month for the ninth month, where it becomes evident that the cow will not be giving a fair flow of milk at the end of the ninth month.

Provision was made for keeping a record of these tests in the yearly record book outlined previously. To get the average yearly test, when more than one test in the year is made the tests should be added together, and the sum divided by the number of tests made. The amount of milk produced in a year multiplied by the average test will give the yearly amount of fat produced by the cow in a year. To get the estimated yield of butter in a year divide the butter fat by six, and add the answer thus obtained to the butter fat. This one-sixth added to the butter fat represents the amount of water and salt there is in average butter, and is called the overrun.

Reference has been made to the composite test. A composite sample of milk is a sample made up of a small portion from each of a number of milkings from the same cow. These samples are taken at the time of milking, and placed in a jar provided for this purpose, and all are thoroughly mixed together. In taking a composite sample where it is intended to test once a month, at least four days' milk should be included. Where the test is to be made from one to three times a year the samples should be taken for a week. This will minimize the likelihood of any temporary unnatural condition to interfere with the correctness of the test. Further, these composite samples should not be taken when there is any visible signs of anything unnatural in the condition of the animal. Outside conditions have their effect. Excitement caused by moving an animal from one barn to another, or from one herd to another, may affect the test for several days, or until the animal becomes thoroughly accustomed to new surroundings. Any excitement, such as chasing with dogs, will affect the test for a couple of milkings. Sexual heat often has its effects. A sudden change in the nature of the food will cause a decided change for a few days, and no cow should be tested for a few days after being turned on a good pasture from dry feed. The composite sample is usually preserved in a glass jar, with a close-fitting cover, to prevent evaporation. The samples taken from each milking should be approximately equal, and a good contrivance for taking this sample is a brass cartridge for a ten or twelve gauge shotgun, soldered to a copper wire. A cartridge of this size holds about the right amount to be taken from each milking. Of course, a small tin dipper, that will hold about the same amount, could be cheaply made, and would be as good.

It is necessary to make some provision to keep the composite sample from souring during warm weather, and for this some dairy supply firms handle a small tablet that dissolves in the jar as the milk is added to it, and prevents souring. This Station uses a saturated solution of corrosive sublimate (bichloride of mercury). To make this a

small portion of corrosive sublimate is put in a bottle, and the bottle filled with water, and the whole allowed to stand for a couple of days, when the water will have dissolved all of the material that it will hold. This bottle is filled with water from time to time, until all of the sublimate is dissolved, when more should be added. This solution is measured into the jars with the same pipette used for measuring the milk into the test bottles, one pipette being sufficient for three jars. Too much care cannot be taken in handling and keeping this solution, as it is a deadly poison, though very innocent looking, and it does not change the appearance or taste of the milk in the least. Practically all preservatives used for this purpose are more or less poisonous, and all are good for the purpose for which they are intended.

Further than the description of the composite sample, it is not the intention of the writer to enter into a discussion of the test, but this Station stands ready to send a list of detailed rules for using the test on application, though with practically every test sent out when purchased a good set of rules are supplied.

### ILLUSTRATIONS.

On pages 23 and 24 are given the pictures of two cows in the Experiment Station herd. These cows were of the same age, had the same sire and the same general treatment throughout; yet were animals of very different dairy value.

By keeping Milk and Butter records it was shown that cow No. 1 had a capacity of 6,100 lbs. of milk and 370 lbs. of butter per year, while cow No. 2 had a capacity of 4,700 lbs. of milk and 270 lbs. of butter per year. This made cow No. 1 when on the same feed and receiving the same attentions in every way give about \$25.00 per year more product than cow No. 2. Estimating the milk at 16 cents per gallon and butter at 25 cents per pound.



COW No. 1, MILK YIELD 6100 LBS. BUTTER 370 LBS. (See Page 22 For Details.)



COW No. 2, MILK YIELD 4700 LBS. BUTTER YIELD 270 LBS. (See Page 22 For Details.)

# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 95,

August, 1904.

## The Character of Milk During the Period of Heat. (Oestrus.)

By C. F. Doane.

The demand of many consumers and boards of health for milk of high quality and healthfulness, and the efforts of the most advanced dairymen to meet this demand, has caused a rigid search into all phases of the physical condition of the cow and her surroundings, in order that every means possible may be adopted for getting better milk.

In this effort to procure a healthful and normal milk supply the idea has been advanced by some high authorities that the milk of a cow, during the "period of heat" was in an abnormal condition, and not proper food, particularly for infants and invalids.

It is commonly recognized that any unusual excitement or exercise changes the composition of the milk, this being particularly noticeable in the fat content.

The "period of heat" is a perfectly natural function of the animal, and it is doubtful if the conditions surrounding this time should be classed among the unusual or unnatural, and whether any material change should occur in the milk.

### OPINIONS AND RESULTS OF OTHER INVESTIGATORS ON THIS SUBJECT.

There have been a number of opinions recorded as to the character of the milk at this period, but most of them have been based upon a limited number of analyses, and generally only a single constituent has been determined. Then, again, as far as the data recorded shows, there have been no analyses given of the milk from the same cows when in their normal condition.

Fleischman says that in the case of some animals there is no noticeable change, while with others the effect may be very marked, especially on the per cent. of fat, which dropped from the normal of 3.5% to 0.7%. He also states that milk may curdle on being heated to the boiling point, owing to the presence of an abnormal quantity of albumen.

Dr. F. Schaffer, in *Naturforschenden Gesellschaft*, gives the analysis of one cow's milk during heat as follows:

|                        |        |
|------------------------|--------|
| Specific gravity ..... | 10.383 |
| Sugar .....            | 4.50 % |
| Acidity .....          | 0.27 % |
| Total protein .....    | 5.72 % |

The normal composition of the milk of this cow was not given, but it will be noticed that both the protein and the acidity are higher than average normal milk.

Von Klenze states that the milk at the "period of heat" is rich in proteids, and gives as his opinion that milk in this condition is unfit for making the better kinds of cheese.

## PLANS OF EXPERIMENT.

With the idea of giving some more detailed information on this subject the experiments recorded in the following pages were conducted by this Station. The general plan of the work was to make daily analysis of a composite sample of the milk from the cows selected for the test during the normal period, either just before, or after the "period of heat," and analyses of the morning's and evening's milk separately, during the period. The "period of heat" was presumed to cover two days.

This investigation was suggested by Maj. H. E. Alvord, Chief of the Dairy Division of the U. S. Department of Agriculture. The chemical work was performed by T. M. Price, Assistant Chemist of the Station. The other details of the work, and the writing up and discussion of the results were performed by the author.

## ANIMALS AND METHODS USED IN THE INVESTIGATION.

For this work five cows were used, two of them being used through two periods each. The cows, as a rule, were of a quiet disposition, showing very little excitement or nervousness during the "period," and they exercised themselves very little, even though they were purposely allowed to remain in the yard with the balance of the herd during the day. The temperature of the cows was taken daily, and observations made on the physical appearance; but these tests showed only normal results. Total solids, total protein, fat, sugar and casein were determined according to the methods adopted by the Association of Official Agricultural Chemists. The difference between the total protein and the casein was assumed to equal the albumen, as the amount of proteids is so small that they need not be considered in this discussion.

## RESULTS.

From the results given in the tables, it will be noted that cows 21 and 15 showed an increase of about one per cent. in the amount of fat during the second and third days, and there was practically no

variation in the other solids. With the other three cows in the test there was no appreciable variation in any of the constituents. It will be noticed that cow No. 41 came in "heat" on March 17th, and again on March 24th. This was a much shorter time between "periods" than normal, and is an unusual, but not infrequent, occurrence, and is well known to veterinarians and others familiar with cows. This short time between "periods" continued with this cow (No. 41) for several months.

It will be noted that none of the cows in this test showed a lower per cent. of fat than normal during the "period of heat." This was unexpected, both according to general belief and according to some previous tests made by the author. The determination in this test showed no change in the amount of albumen, which also was different from the reports made by the German investigators.

From these results, and as far as chemical analyses show, it would seem that the milk from cows during the "period of heat" is in a practically normal condition, and fit for consumption.

While the chemical analysis shows the milk to be practically normal, yet there is a possibility that it may contain some physical characteristics, or enzymes, which, when consumed by an infant or invalid, would disagree with them. This view is in a measure indicated by the observations which have frequently been recorded of a child showing symptoms of poisoning, if it nurses soon after the mother had experienced a severe fright. The determination of the nature of such a condition in the milk, and the following out of its effects, when the milk was used as a food, is very difficult and hard to demonstrate.

TABLE 1—*Showing the Composition of Cows' Milk During the Normal and Oestrus Periods.*

| No. Cow. | Date.                   | Total Solids. | Fat. | Protein. | Casein. | Sugar. | Conditions of Animal. |
|----------|-------------------------|---------------|------|----------|---------|--------|-----------------------|
| 21       | Nov. 29                 | 14.20         | 5.00 | 3.51     | 2.71    | 4.83   | Normal.               |
| 21       | Nov. 30                 | 14.26         | 4.90 | 3.49     | 2.69    | 5.00   | Normal.               |
| 21       | Dec. 1                  | 14.41         | 4.90 | 3.54     | 2.75    | 4.73   | Normal.               |
| 21       | Dec. 2                  | 14.36         | 4.90 | 3.44     | 2.62    | 4.93   | Normal.               |
| 21       | Dec. 3                  | 14.47         | 5.20 | 3.50     | 2.71    | 5.09   | Normal.               |
| 21       | Dec. 4                  | 14.45         | 5.40 | 3.51     | 2.68    | 4.80   | Normal.               |
| 21       | Dec. 5                  | 14.66         | 6.00 | 3.48     | 2.69    | 4.62   | Normal.               |
| 21       | Dec. 6                  | 14.43         | 5.30 | 3.51     | 2.66    | 4.95   | Normal.               |
| 21       | Dec. 7                  | 14.43         | 5.30 | 3.51     | 2.63    | 4.64   | Normal.               |
| 21       | Dec. 8 <sup>a.m.</sup>  | 14.43         | 5.20 | 3.52     | 2.68    | 5.10   | Heat.                 |
| 21       | Dec. 8 <sup>p.m.</sup>  | 14.62         | 5.50 | 3.46     | 2.73    | 4.83   | Heat.                 |
| 21       | Dec. 9 <sup>a.m.</sup>  | 15.11         | 6.80 | 3.42     | 2.52    | 5.08   | Heat.                 |
| 21       | Dec. 9 <sup>p.m.</sup>  | 14.72         | 5.00 | 3.38     | 2.72    | 5.00   | Heat.                 |
| 21       | Dec. 10 <sup>a.m.</sup> | 14.73         | 5.60 | 3.38     | 2.70    | 5.01   | Heat.                 |
| 21       | Dec. 10 <sup>p.m.</sup> | 15.11         | 6.10 | 3.35     | 2.69    | 4.89   | Heat                  |
| 21       | Dec. 11                 | 14.93         | 5.30 | 3.40     | 2.67    | 4.75   | Normal.               |
| 21       | Dec. 12                 | 14.56         | 5.20 | 3.39     | 2.73    | 5.06   | Normal.               |
| 21       | Dec. 13                 | 14.52         | 5.40 | 3.43     | 2.73    | 4.80   | Normal.               |

TABLE 1—Continued—*Showing the Composition of Cows' Milk During the Normal and Oestrus Periods.*

| No. Cow. | Date.   | Total Solids. | Fat. | Protein. | Casein. | Sugar. | Conditions of Animal. |
|----------|---------|---------------|------|----------|---------|--------|-----------------------|
| 15       | Jan. 8  | 13.18         | 3.50 | 2.87     | 2.28    | 4.60   | Normal.               |
| 15       | Jan. 9  | 12.94         | 4.00 | 2.90     | 2.31    | 4.72   | Normal.               |
| 15       | Jan. 10 | 13.09         | 4.40 | 3.01     | 2.34    | 4.73   | Normal.               |
| 15       | Jan. 11 | 12.64         | 4.00 | 3.03     | 2.33    | 4.70   | Normal.               |
| 15       | Jan. 12 | 12.83         | 5.20 | 3.01     | 2.36    | 4.81   | Normal.               |
| 15       | Jan. 13 | 13.08         | 4.20 | 2.96     | 2.34    | 4.84   | Normal.               |
| 15       | Jan. 14 | 12.66         | 4.20 | 2.96     | 2.26    | 4.82   | Normal.               |
| 15       | Jan. 15 | 13.08         | 4.10 | 2.91     | 2.33    | 4.76   | Normal.               |
| 15       | Jan. 16 | 12.57         | 4.00 | 2.98     | 2.28    | 4.76   | Normal.               |
| 15       | Jan. 17 | 12.92         | 4.00 | 3.23     | 2.32    | 4.66   | Normal.               |
| 15       | Jan. 18 | 12.70         | 3.90 | 3.21     | 2.26    | 4.72   | Normal.               |
| 15       | Jan. 19 | 12.70         | 4.00 | 3.19     | 2.19    | 4.68   | Normal.               |
| 15       | Jan. 20 | 12.89         | 4.00 | 3.21     | 2.32    | 4.80   | Normal.               |
| 15       | Jan. 21 | 12.41         | 3.80 | 3.09     | 2.27    | 4.84   | Normal.               |
| 15       | Jan. 22 | 12.09         | 3.90 | 3.13     | 2.22    | 4.81   | Normal.               |
| 15       | Jan. 23 | 12.49         | 4.20 | 2.98     | 2.26    | 4.81   | Normal.               |
| 15       | Jan. 24 | 12.04         | 3.60 | 2.99     | 2.27    | 4.84   | Normal.               |
| 15       | Jan. 25 | 12.92         | 4.80 | 2.80     | 2.34    | 4.80   | Heat.                 |
| 15       | Jan. 26 | 12.64         | 4.20 | 2.86     | 2.30    | 4.80   | Heat.                 |
| 15       | Jan. 26 | 13.09         | 4.80 | 2.98     | 2.29    | 4.83   | Heat.                 |
| 15       | Jan. 27 | 12.83         | 4.80 | 3.03     | 2.25    | 4.81   | Heat.                 |
| 15       | Jan. 27 | 12.60         | 4.60 | 2.84     | 2.21    | 4.72   | Heat.                 |
| 15       | Jan. 28 | 12.60         | 4.40 | 2.85     | 2.16    | 4.70   | Heat.                 |
| 15       | Jan. 29 | 12.83         | 4.30 | 3.10     | 2.29    | 4.85   | Normal.               |
| 15       | Jan. 30 | 13.00         | 4.90 | 3.17     | 2.24    | 4.85   | Normal.               |
| 15       | Jan. 31 | 12.26         | 4.10 | 2.78     | 2.10    | 4.69   | Normal.               |
| 15       | Feb. 1  | 12.25         | 4.10 | 2.83     | 2.14    | 4.72   | Normal.               |
| 15       | Feb. 2  | 12.22         | 4.00 | 3.00     | 2.22    | 4.81   | Normal.               |
| 15       | Feb. 3  | 13.09         | 4.60 | 3.04     | 2.20    | 4.81   | Normal.               |
| 15       | Feb. 4  | 12.57         | 4.20 | 2.96     | 2.18    | 4.82   | Normal.               |
| 15       | Feb. 5  | 12.50         | 4.20 | 2.80     | 2.14    | 4.80   | Normal.               |
| 15       | Feb. 6  | 12.59         | 4.20 | 2.99     | 2.14    | 4.80   | Normal.               |
| 15       | Feb. 7  | 12.69         | 4.30 | 2.89     | 2.14    | 4.80   | Normal.               |
| 27       | Feb. 11 | 14.42         | 5.00 | 3.13     | 2.27    | 4.90   | Normal.               |
| 27       | Feb. 12 | 14.56         | 5.20 | 3.13     | 2.34    | 4.95   | Normal.               |
| 27       | Feb. 13 | 14.88         | 4.60 | 3.15     | 2.31    | 4.95   | Normal.               |
| 27       | Feb. 14 | 14.96         | 5.00 | 3.15     | 2.31    | 4.90   | Normal.               |
| 27       | Feb. 15 | 15.00         | 6.00 | 3.18     | 2.32    | 4.92   | Normal.               |
| 27       | Feb. 16 | 15.00         | 5.80 | 3.15     | 2.28    | 4.91   | Heat.                 |
| 27       | Feb. 17 | 14.57         | 5.40 | 3.14     | 2.30    | 4.92   | Heat.                 |
| 27       | Feb. 17 | 14.85         | 5.30 | 3.15     | 2.32    | 4.92   | Heat.                 |
| 27       | Feb. 18 | 14.63         | 5.20 | 3.18     | 2.31    | 4.92   | Heat.                 |
| 27       | Feb. 18 | 15.00         | 6.20 | 3.22     | 2.32    | 4.93   | Heat.                 |
| 27       | Feb. 19 | 14.10         | 4.80 | 3.09     | 2.24    | 5.01   | Heat.                 |
| 27       | Feb. 19 | 14.20         | 4.80 | 3.02     | 2.21    | 4.94   | Heat.                 |

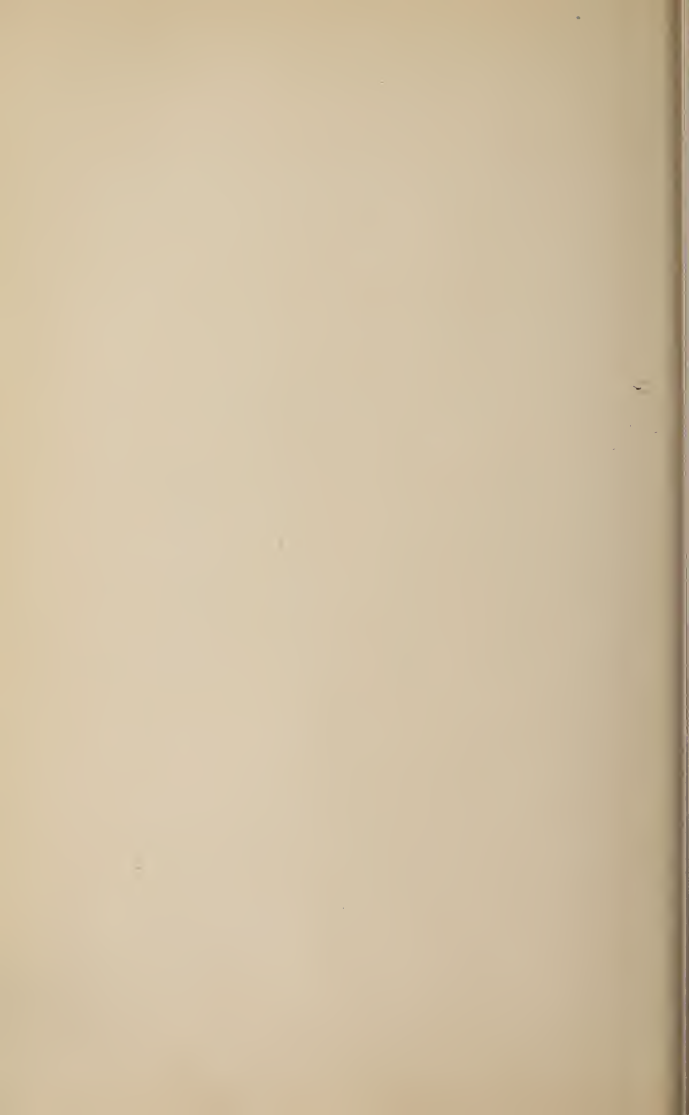
TABLE 1—Continued—*Showing the Composition of Cows' Milk During the Normal and Oestrus Periods.*

| No. Cow. | Date.   | Total Solids. | Fat. | Protein. | Casein. | Sugar. | Conditions of Animal. |
|----------|---------|---------------|------|----------|---------|--------|-----------------------|
| 27       | Feb. 20 | 14.90         | 5.40 | 3.17     | 2.31    | 4.87   | Normal.               |
| 27       | Feb. 21 | 14.41         | 4.90 | 3.12     | 2.34    | 4.84   | Normal.               |
| 27       | Feb. 22 | 14.79         | 4.80 | 3.10     | 2.30    | 4.92   | Normal.               |
| 27       | Feb. 23 | 14.98         | 5.60 | 3.20     | 2.36    | 5.01   | Normal.               |
| 27       | Feb. 24 | 14.41         | 4.80 | 3.12     | 2.19    | 4.88   | Normal.               |
| 27       | Feb. 25 | 14.39         | 4.80 | 3.14     | 2.14    | 4.96   | Normal.               |
| 27       | Feb. 26 | 14.68         | 4.60 | 3.14     | 2.21    | 4.94   | Normal.               |
| 27       | Feb. 27 | 14.74         | 4.90 | 3.16     | 2.28    | 4.92   | Normal.               |
| 15       | Feb. 28 | 12.43         | 3.80 | 3.26     | 2.22    | 4.72   | Normal.               |
| 15       | Mar. 1  | 13.36         | 4.10 | 3.29     | 2.32    | 4.71   | Normal.               |
| 15       | Mar. 2  | 13.00         | 4.20 | 3.33     | 2.21    | 4.70   | Normal.               |
| 15       | Mar. 3  | 13.22         | 4.50 | 3.30     | 2.28    | 4.70   | Heat.                 |
| 15       | Mar. 3  | 14.00         | 4.60 | 3.32     | 2.27    | 4.70   | Heat.                 |
| 15       | Mar. 4  | 13.68         | 4.40 | 3.31     | 2.32    | 4.71   | Heat.                 |
| 15       | Mar. 5  | 13.80         | 4.50 | 3.32     | 2.31    | 4.70   | Normal.               |
| 15       | Mar. 6  | 13.26         | 4.35 | 3.70     | 2.30    | 4.80   | Normal.               |
| 15       | Mar. 7  | 12.80         | 4.20 | 3.29     | 2.29    | 4.72   | Normal.               |
| 15       | Mar. 8  | 12.66         | 4.30 | 3.19     | 2.30    | 4.70   | Normal.               |
| 15       | Mar. 9  | 12.36         | 4.30 | 3.22     | 2.31    | 4.70   | Normal.               |
| 15       | Mar. 10 | 12.45         | 4.30 | 3.32     | 2.29    | 4.74   | Normal.               |
| 15       | Mar. 11 | 12.81         | 4.40 | 3.30     | 2.31    | 4.71   | Normal.               |
| 15       | Mar. 12 | 12.80         | 4.30 | 3.31     | 2.28    | 4.74   | Normal.               |
| 41       | Mar. 16 | 15.32         | 6.10 | 3.40     | 2.32    | 4.84   | Normal.               |
| 41       | Mar. 17 | 14.81         | 5.50 | 3.37     | 2.32    | 4.94   | Heat.                 |
| 41       | Mar. 17 | 15.06         | 5.40 | 3.47     | 2.33    | 4.82   | Heat.                 |
| 41       | Mar. 18 | 14.90         | 6.00 | 3.47     | 2.31    | 4.84   | Heat.                 |
| 41       | Mar. 18 | 14.61         | 5.10 | 3.34     | 2.33    | 4.86   | Heat.                 |
| 41       | Mar. 19 | 15.20         | 6.10 | 3.34     | 2.34    | 4.82   | Normal.               |
| 41       | Mar. 20 | 15.06         | 5.40 | 3.39     | 2.34    | 4.81   | Normal.               |
| 41       | Mar. 21 | 14.89         | 5.40 | 3.34     | 2.32    | 4.82   | Normal.               |
| 41       | Mar. 22 | 15.29         | 6.10 | 3.31     | 2.32    | 4.76   | Normal.               |
| 41       | Mar. 23 | 15.10         | 5.50 | 3.37     | 2.30    | 4.76   | Normal.               |
| 41       | Mar. 24 | 14.48         | 5.40 | 3.40     | 2.31    | 4.78   | Heat.                 |
| 41       | Mar. 24 | 14.60         | 5.40 | 3.35     | 2.34    | 4.82   | Heat.                 |
| 41       | Mar. 25 | 14.70         | 5.40 | 3.40     | 2.34    | 4.80   | Heat.                 |
| 41       | Mar. 25 | 14.82         | 5.40 | 3.40     | 2.34    | 4.80   | Heat.                 |
| 41       | Mar. 26 | 14.47         | 5.40 | 3.33     | 2.29    | 4.76   | Normal.               |
| 29       | Mar. 30 | 13.30         | 4.80 | 3.30     | 2.36    | 4.84   | Heat.                 |
| 29       | Mar. 30 | 13.57         | 5.00 | 3.32     | 2.38    | 4.76   | Heat.                 |
| 29       | Mar. 31 | 13.28         | 4.80 | 3.29     | 2.38    | 4.70   | Heat.                 |
| 29       | Mar. 31 | 14.00         | 4.80 | 3.20     | 2.39    | 4.70   | Heat.                 |
| 29       | Apr. 1  | 13.86         | 5.00 | 3.24     | 2.36    | 4.70   | Normal.               |

TABLE 2—*Average Composition of Cows' Milk During the Normal and Oestrus Periods.*

| Cow No.    | Condition. | Fat. | Protein. | Casein. | Sugar. |
|------------|------------|------|----------|---------|--------|
| 21         | Normal.    | 5.2  | 3.49     | 2.69    | 5.21   |
|            | Heat.      | 5.7  | 3.42     | 2.57    | 4.99   |
| 27         | Normal.    | 5.1  | 3.14     | 2.28    | 4.92   |
|            | Heat.      | 5.3  | 3.13     | 2.28    | 4.94   |
| 41         | Normal.    | 5.7  | 3.35     | 2.39    | 4.81   |
|            | Heat.      | 5.4  | 3.40     | 2.33    | 4.83   |
| 15         | Normal.    | 4.2  | 3.19     | 2.27    | 4.74   |
|            | Heat.      | 4.5  | 3.27     | 2.28    | 2.73   |
| Av. of all | Normal.    | 5.1  | 3.29     | 2.41    | 4.92   |
|            | Heat.      | 5.2  | 3.20     | 2.37    | 4.87   |





# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 95,

August, 1904.

## The Character of Milk During the Period of Heat. (Oestrus.)

By C. F. Doane.

The demand of many consumers and boards of health for milk of high quality and healthfulness, and the efforts of the most advanced dairymen to meet this demand, has caused a rigid search into all phases of the physical condition of the cow and her surroundings, in order that every means possible may be adopted for getting better milk.

In this effort to procure a healthful and normal milk supply the idea has been advanced by some high authorities that the milk of a cow, during the "period of heat" was in an abnormal condition, and not proper food, particularly for infants and invalids.

It is commonly recognized that any unusual excitement or exercise changes the composition of the milk, this being particularly noticeable in the fat content.

The "period of heat" is a perfectly natural function of the animal, and it is doubtful if the conditions surrounding this time should be classed among the unusual or unnatural, and whether any material change should occur in the milk.

### OPINIONS AND RESULTS OF OTHER INVESTIGATORS ON THIS SUBJECT.

There have been a number of opinions recorded as to the character of the milk at this period, but most of them have been based upon a limited number of analyses, and generally only a single constituent has been determined. Then, again, as far as the data recorded shows, there have been no analyses given of the milk from the same cows when in their normal condition.

Fleischman says that in the case of some animals there is no noticeable change, while with others the effect may be very marked, especially on the per cent. of fat, which dropped from the normal of 3.5% to 0.7%. He also states that milk may curdle on being heated to the boiling point, owing to the presence of an abnormal quantity of albumen.

Dr. F. Schaffer, in *Naturforschenden Gesellschaft*, gives the analysis of one cow's milk during heat as follows:

|                        |        |
|------------------------|--------|
| Specific gravity ..... | 10.383 |
| Sugar .....            | 4.50 % |
| Acidity .....          | 0.27 % |
| Total protein .....    | 5.72 % |

The normal composition of the milk of this cow was not given, but it will be noticed that both the protein and the acidity are higher than average normal milk.

Von Klenze states that the milk at the "period of heat" is rich in proteids, and gives as his opinion that milk in this condition is unfit for making the better kinds of cheese.

### PLANS OF EXPERIMENT.

With the idea of giving some more detailed information on this subject the experiments recorded in the following pages were conducted by this Station. The general plan of the work was to make daily analysis of a composite sample of the milk from the cows selected for the test during the normal period, either just before, or after the "period of heat," and analyses of the morning's and evening's milk separately, during the period. The "period of heat" was presumed to cover two days.

This investigation was suggested by Maj. H. E. Alvord, Chief of the Dairy Division of the U. S. Department of Agriculture. The chemical work was performed by T. M. Price, Assistant Chemist of the Station. The other details of the work, and the writing up and discussion of the results were performed by the author.

### ANIMALS AND METHODS USED IN THE INVESTIGATION.

For this work five cows were used, two of them being used through two periods each. The cows, as a rule, were of a quiet disposition, showing very little excitement or nervousness during the "period," and they exercised themselves very little, even though they were purposely allowed to remain in the yard with the balance of the herd during the day. The temperature of the cows was taken daily, and observations made on the physical appearance; but these tests showed only normal results. Total solids, total protein, fat, sugar and casein were determined according to the methods adopted by the Association of Official Agricultural Chemists. The difference between the total protein and the casein was assumed to equal the albumen, as the amount of proteids is so small that they need not be considered in this discussion.

### RESULTS.

From the results given in the tables, it will be noted that cows 21 and 15 showed an increase of about one per cent. in the amount of fat during the second and third days, and there was practically no

variation in the other solids. With the other three cows in the test there was no appreciable variation in any of the constituents. It will be noticed that cow No. 41 came in "heat" on March 17th, and again on March 24th. This was a much shorter time between "periods" than normal, and is an unusual, but not infrequent, occurrence, and is well known to veterinarians and others familiar with cows. This short time between "periods" continued with this cow (No. 41) for several months.

It will be noted that none of the cows in this test showed a lower per cent. of fat than normal during the "period of heat." This was unexpected, both according to general belief and according to some previous tests made by the author. The determination in this test showed no change in the amount of albumen, which also was different from the reports made by the German investigators.

From these results, and as far as chemical analyses show, it would seem that the milk from cows during the "period of heat" is in a practically normal condition, and fit for consumption.

While the chemical analysis shows the milk to be practically normal, yet there is a possibility that it may contain some physical characteristics, or enzymes, which, when consumed by an infant or invalid, would disagree with them. This view is in a measure indicated by the observations which have frequently been recorded of a child showing symptoms of poisoning, if it nurses soon after the mother had experienced a severe fright. The determination of the nature of such a condition in the milk, and the following out of its effects, when the milk was used as a food, is very difficult and hard to demonstrate.

TABLE 1.—*Showing the Composition of Cows' Milk During the Normal and Oestrus Periods.*

| No. Cow. | Date.                   | Total Solids. | Fat. | Protein. | Casein. | Sugar. | Conditions of Animal. |
|----------|-------------------------|---------------|------|----------|---------|--------|-----------------------|
| 21       | Nov. 29                 | 14.20         | 5.00 | 3.51     | 2.71    | 4.83   | Normal.               |
| 21       | Nov. 30                 | 14.26         | 4.90 | 3.49     | 2.69    | 5.00   | Normal.               |
| 21       | Dec. 1                  | 14.41         | 4.90 | 3.54     | 2.75    | 4.73   | Normal.               |
| 21       | Dec. 2                  | 14.36         | 4.90 | 3.44     | 2.62    | 4.93   | Normal.               |
| 21       | Dec. 3                  | 14.47         | 5.20 | 3.50     | 2.71    | 5.09   | Normal.               |
| 21       | Dec. 4                  | 14.45         | 5.40 | 3.51     | 2.68    | 4.80   | Normal.               |
| 21       | Dec. 5                  | 14.66         | 6.00 | 3.48     | 2.69    | 4.62   | Normal.               |
| 21       | Dec. 6                  | 14.43         | 5.30 | 3.51     | 2.66    | 4.95   | Normal.               |
| 21       | Dec. 7                  | 14.43         | 5.30 | 3.51     | 2.63    | 4.64   | Normal.               |
| 21       | Dec. 8 <sup>a.m.</sup>  | 14.43         | 5.20 | 3.52     | 2.68    | 5.10   | Heat.                 |
| 21       | Dec. 8 <sup>p.m.</sup>  | 14.62         | 5.50 | 3.46     | 2.73    | 4.83   | Heat.                 |
| 21       | Dec. 9 <sup>a.m.</sup>  | 15.11         | 6.80 | 3.42     | 2.52    | 5.08   | Heat.                 |
| 21       | Dec. 9 <sup>p.m.</sup>  | 14.72         | 5.00 | 3.38     | 2.72    | 5.00   | Heat.                 |
| 21       | Dec. 10 <sup>a.m.</sup> | 14.73         | 5.60 | 3.38     | 2.70    | 5.01   | Heat.                 |
| 21       | Dec. 10 <sup>p.m.</sup> | 15.11         | 6.10 | 3.35     | 2.69    | 4.89   | Heat.                 |
| 21       | Dec. 11                 | 14.93         | 5.30 | 3.40     | 2.67    | 4.75   | Normal.               |
| 21       | Dec. 12                 | 14.56         | 5.20 | 3.39     | 2.73    | 5.06   | Normal.               |
| 21       | Dec. 13                 | 14.52         | 5.40 | 3.43     | 2.73    | 4.80   | Normal.               |

TABLE 1—Continued—*Showing the Composition of Cows' Milk During the Normal and Oestrus Periods.*

| No. Cow. | Date. | Total Solids. | Fat.  | Protein. | Casein. | Sugar. | Conditions of Animal. |         |
|----------|-------|---------------|-------|----------|---------|--------|-----------------------|---------|
| 15       | Jan.  | 8             | 13.18 | 3.50     | 2.87    | 2.28   | 4.60                  | Normal. |
| 15       | Jan.  | 9             | 12.94 | 4.00     | 2.90    | 2.31   | 4.72                  | Normal. |
| 15       | Jan.  | 10            | 13.00 | 4.40     | 3.01    | 2.34   | 4.73                  | Normal. |
| 15       | Jan.  | 11            | 12.64 | 4.00     | 3.03    | 2.33   | 4.70                  | Normal. |
| 15       | Jan.  | 12            | 12.83 | 5.20     | 3.01    | 2.36   | 4.81                  | Normal. |
| 15       | Jan.  | 13            | 13.08 | 4.20     | 2.96    | 2.34   | 4.84                  | Normal. |
| 15       | Jan.  | 14            | 12.66 | 4.20     | 2.96    | 2.26   | 4.82                  | Normal. |
| 15       | Jan.  | 15            | 13.08 | 4.10     | 2.91    | 2.33   | 4.76                  | Normal. |
| 15       | Jan.  | 16            | 12.57 | 4.00     | 2.98    | 2.28   | 4.76                  | Normal. |
| 15       | Jan.  | 17            | 12.92 | 4.00     | 3.23    | 2.32   | 4.66                  | Normal. |
| 15       | Jan.  | 18            | 12.70 | 3.90     | 3.21    | 2.26   | 4.72                  | Normal. |
| 15       | Jan.  | 19            | 12.70 | 4.00     | 3.19    | 2.19   | 4.68                  | Normal. |
| 15       | Jan.  | 20            | 12.89 | 4.00     | 3.21    | 2.32   | 4.80                  | Normal. |
| 15       | Jan.  | 21            | 12.41 | 3.80     | 3.09    | 2.27   | 4.84                  | Normal. |
| 15       | Jan.  | 22            | 12.00 | 3.90     | 3.13    | 2.22   | 4.81                  | Normal. |
| 15       | Jan.  | 23            | 12.49 | 4.20     | 2.98    | 2.26   | 4.81                  | Normal. |
| 15       | Jan.  | 24            | 12.04 | 3.60     | 2.99    | 2.27   | 4.84                  | Normal. |
| 15       | Jan.  | 25            | 12.92 | 4.80     | 2.80    | 2.34   | 4.80                  | Heat.   |
| 15       | Jan.  | 26            | 12.64 | 4.20     | 2.86    | 2.30   | 4.80                  | Heat.   |
| 15       | Jan.  | 26            | 13.09 | 4.80     | 2.98    | 2.29   | 4.83                  | Heat.   |
| 15       | Jan.  | 27            | 12.83 | 4.80     | 3.03    | 2.25   | 4.81                  | Heat.   |
| 15       | Jan.  | 27            | 12.60 | 4.60     | 2.84    | 2.21   | 4.72                  | Heat.   |
| 15       | Jan.  | 28            | 12.60 | 4.40     | 2.85    | 2.16   | 4.70                  | Heat.   |
| 15       | Jan.  | 29            | 12.83 | 4.50     | 3.10    | 2.29   | 4.85                  | Normal. |
| 15       | Jan.  | 30            | 13.00 | 4.90     | 3.17    | 2.24   | 4.85                  | Normal. |
| 15       | Jan.  | 31            | 12.26 | 4.10     | 2.78    | 2.10   | 4.69                  | Normal. |
| 15       | Feb.  | 1             | 12.25 | 4.10     | 2.83    | 2.14   | 4.72                  | Normal. |
| 15       | Feb.  | 2             | 12.22 | 4.00     | 3.00    | 2.22   | 4.81                  | Normal. |
| 15       | Feb.  | 3             | 13.09 | 4.60     | 3.04    | 2.20   | 4.81                  | Normal. |
| 15       | Feb.  | 4             | 12.57 | 4.20     | 2.96    | 2.18   | 4.82                  | Normal. |
| 15       | Feb.  | 5             | 12.50 | 4.20     | 2.80    | 2.14   | 4.80                  | Normal. |
| 15       | Feb.  | 6             | 12.59 | 4.20     | 2.99    | 2.14   | 4.80                  | Normal. |
| 15       | Feb.  | 7             | 12.69 | 4.30     | 2.89    | 2.14   | 4.80                  | Normal. |
| 27       | Feb.  | 11            | 14.42 | 5.00     | 3.13    | 2.27   | 4.90                  | Normal. |
| 27       | Feb.  | 12            | 14.56 | 5.20     | 3.13    | 2.34   | 4.95                  | Normal. |
| 27       | Feb.  | 13            | 14.88 | 4.60     | 3.15    | 2.31   | 4.95                  | Normal. |
| 27       | Feb.  | 14            | 14.96 | 5.00     | 3.15    | 2.31   | 4.90                  | Normal. |
| 27       | Feb.  | 15            | 15.00 | 6.00     | 3.18    | 2.32   | 4.92                  | Normal. |
| 27       | Feb.  | 16            | 15.00 | 5.80     | 3.15    | 2.28   | 4.91                  | Heat.   |
| 27       | Feb.  | 17            | 14.57 | 5.40     | 3.14    | 2.30   | 4.92                  | Heat.   |
| 27       | Feb.  | 17            | 14.85 | 5.30     | 3.15    | 2.32   | 4.92                  | Heat.   |
| 27       | Feb.  | 18            | 14.63 | 5.20     | 3.18    | 2.31   | 4.92                  | Heat.   |
| 27       | Feb.  | 18            | 15.00 | 6.20     | 3.22    | 2.32   | 4.93                  | Heat.   |
| 27       | Feb.  | 19            | 14.10 | 4.80     | 3.09    | 2.24   | 5.01                  | Heat.   |
| 27       | Feb.  | 19            | 14.20 | 4.80     | 3.02    | 2.21   | 4.94                  | Heat.   |

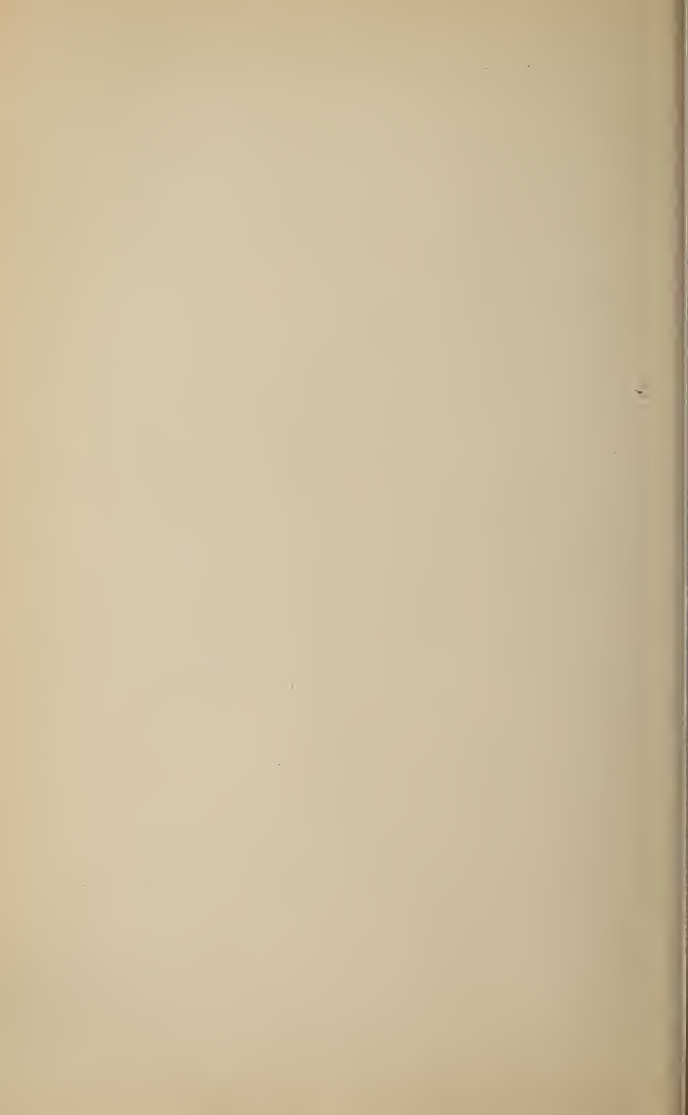
TABLE 1—Continued—*Showing the Composition of Cows' Milk During the Normal and Oestrus Periods.*

| No. Cow. | Date.   | Total Solids. | Fat. | Protein. | Casein. | Sugar. | Conditions of Animal. |
|----------|---------|---------------|------|----------|---------|--------|-----------------------|
| 27       | Feb. 20 | 14.90         | 5.40 | 3.17     | 2.31    | 4.87   | Normal.               |
| 27       | Feb. 21 | 14.41         | 4.90 | 3.12     | 2.34    | 4.84   | Normal.               |
| 27       | Feb. 22 | 14.79         | 4.80 | 3.10     | 2.30    | 4.92   | Normal.               |
| 27       | Feb. 23 | 14.98         | 5.60 | 3.20     | 2.36    | 5.01   | Normal.               |
| 27       | Feb. 24 | 14.41         | 4.80 | 3.12     | 2.19    | 4.88   | Normal.               |
| 27       | Feb. 25 | 14.39         | 4.80 | 3.14     | 2.14    | 4.96   | Normal.               |
| 27       | Feb. 26 | 14.68         | 4.60 | 3.14     | 2.21    | 4.94   | Normal.               |
| 27       | Feb. 27 | 14.74         | 4.90 | 3.16     | 2.28    | 4.92   | Normal.               |
| 15       | Feb. 28 | 12.43         | 3.80 | 3.26     | 2.22    | 4.72   | Normal.               |
| 15       | Mar. 1  | 13.36         | 4.10 | 3.29     | 2.32    | 4.71   | Normal.               |
| 15       | Mar. 2  | 13.00         | 4.20 | 3.33     | 2.21    | 4.70   | Normal.               |
| 15       | Mar. 3  | 13.22         | 4.50 | 3.30     | 2.28    | 4.70   | Heat.                 |
| 15       | Mar. 3  | 14.00         | 4.60 | 3.32     | 2.27    | 4.70   | Heat.                 |
| 15       | Mar. 4  | 13.68         | 4.40 | 3.31     | 2.32    | 4.71   | Heat.                 |
| 15       | Mar. 5  | 13.80         | 4.50 | 3.32     | 2.31    | 4.70   | Normal.               |
| 15       | Mar. 6  | 13.26         | 4.35 | 3.70     | 2.30    | 4.80   | Normal.               |
| 15       | Mar. 7  | 12.80         | 4.20 | 3.29     | 2.29    | 4.72   | Normal.               |
| 15       | Mar. 8  | 12.66         | 4.30 | 3.19     | 2.30    | 4.70   | Normal.               |
| 15       | Mar. 9  | 12.36         | 4.30 | 3.22     | 2.31    | 4.70   | Normal.               |
| 15       | Mar. 10 | 12.45         | 4.30 | 3.32     | 2.29    | 4.74   | Normal.               |
| 15       | Mar. 11 | 12.81         | 4.40 | 3.30     | 2.31    | 4.71   | Normal.               |
| 15       | Mar. 12 | 12.80         | 4.30 | 3.31     | 2.28    | 4.74   | Normal.               |
| 41       | Mar. 16 | 15.32         | 6.10 | 3.40     | 2.32    | 4.84   | Normal.               |
| 41       | Mar. 17 | 14.81         | 5.50 | 3.37     | 2.32    | 4.94   | Heat.                 |
| 41       | Mar. 17 | 15.06         | 5.40 | 3.47     | 2.33    | 4.82   | Heat.                 |
| 41       | Mar. 18 | 14.90         | 6.00 | 3.47     | 2.31    | 4.84   | Heat.                 |
| 41       | Mar. 18 | 14.61         | 5.10 | 3.34     | 2.33    | 4.86   | Heat.                 |
| 41       | Mar. 19 | 15.20         | 6.10 | 3.34     | 2.34    | 4.82   | Normal.               |
| 41       | Mar. 20 | 15.06         | 5.40 | 3.39     | 2.34    | 4.81   | Normal.               |
| 41       | Mar. 21 | 14.89         | 5.40 | 3.34     | 2.32    | 4.82   | Normal.               |
| 41       | Mar. 22 | 15.29         | 6.10 | 3.31     | 2.32    | 4.76   | Normal.               |
| 41       | Mar. 23 | 15.10         | 5.50 | 3.37     | 2.30    | 4.76   | Normal.               |
| 41       | Mar. 24 | 14.48         | 5.40 | 3.40     | 2.31    | 4.78   | Heat.                 |
| 41       | Mar. 24 | 14.60         | 5.40 | 3.35     | 2.34    | 4.82   | Heat.                 |
| 41       | Mar. 25 | 14.70         | 5.40 | 3.40     | 2.34    | 4.80   | Heat.                 |
| 41       | Mar. 25 | 14.82         | 5.40 | 3.40     | 2.34    | 4.80   | Heat.                 |
| 41       | Mar. 26 | 14.47         | 5.40 | 3.33     | 2.29    | 4.76   | Normal.               |
| 29       | Mar. 30 | 13.30         | 4.80 | 3.30     | 2.36    | 4.84   | Heat.                 |
| 29       | Mar. 30 | 13.57         | 5.00 | 3.32     | 2.38    | 4.76   | Heat.                 |
| 29       | Mar. 31 | 13.28         | 4.80 | 3.29     | 2.38    | 4.70   | Heat.                 |
| 29       | Mar. 31 | 14.00         | 4.80 | 3.20     | 2.39    | 4.70   | Heat.                 |
| 29       | Apr. 1  | 13.86         | 5.00 | 3.24     | 2.36    | 4.70   | Normal.               |

TABLE 2—*Average Composition of Cows' Milk During the Normal and Oestrus Periods.*

| Cow No.    | Condition. | Fat. | Protein. | Casein. | Sugar. |
|------------|------------|------|----------|---------|--------|
| 21         | Normal.    | 5.2  | 3.49     | 2.69    | 5.21   |
|            | Heat.      | 5.7  | 3.42     | 2.57    | 4.99   |
| 27         | Normal.    | 5.1  | 3.14     | 2.28    | 4.92   |
|            | Heat.      | 5.3  | 3.13     | 2.28    | 4.94   |
| 41         | Normal.    | 5.7  | 3.35     | 2.39    | 4.81   |
|            | Heat.      | 5.4  | 3.40     | 2.33    | 4.83   |
| 15         | Normal.    | 4.2  | 3.19     | 2.27    | 4.74   |
|            | Heat.      | 4.5  | 3.27     | 2.28    | 2.73   |
| Av. of all | Normal.    | 5.1  | 3.29     | 2.41    | 4.92   |
|            | Heat.      | 5.2  | 3.20     | 2.37    | 4.87   |





# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

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Bulletin No. 96,

September, 1904.

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## SWEET CORN.

### Breeding, Growing and Curing for Seed.

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By Augustus Stabler, M. D.

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(Preface by the Director.)

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It has been fully demonstrated that the character of seed used has much to do in determining the quality and quantity of the crop produced. Again, it has been shown that it is not only necessary to have seed from stock giving good crops, but for best results seed should also be from acclimated plants.

Maryland stands fourth in the production of canned corn, devoting annually about 17,000 acres to this crop for canning purposes, and packing about 1,000,000 cases. Besides the amount of corn grown for the canneries there are large areas grown for immediate consumption in the green state. Maryland growers purchase annually from 3,000 to 4,000 bushels of sweet corn seed. The bulk of this seed is grown in the New England States and Northern Ohio.

The reason that our farmers purchase seed from the North is due to the prevailing opinion that Northern-grown seed will give a sweeter corn than the home-grown seed. Then, again, many farmers say that sweet corn will soon run out and deteriorate in other ways, when grown in this climate. In view of our present knowledge of the corn plant these statements did not seem reasonable, and upon investigation they were not borne out by the practices of some of the most successful and advanced growers and packers of sweet corn in Maryland.

Investigations show that the New England growers of sweet corn get an average of from 40 per cent. to 60 per cent. higher yield than the Maryland growers, where both use the same seed. It has also been shown that the yield in Maryland, when home-grown seed is used, is considerably higher than when Northern-grown seed is used. Not only is the yield higher, but repeated observation has shown that the quality of the crop was as good, if not better, and that the plants from home-grown seed stood the climatic changes much better than those from Northern-grown seed.

These facts, taken in connection with the growth of the canning

industry in other States, makes it very evident that Maryland growers must improve their methods, and particularly the quality of the seed they use, if they are to maintain their position in corn canning.

With a view of placing at the disposal of Maryland farmers the best information obtainable on the present methods of growing sweet corn for seed in Maryland, and the methods in use in the New England States, this Station requested Dr. Stabler to prepare this bulletin.

Dr. Augustus Stabler has been identified with the growing of sweet corn in Maryland for a longer time than any other man in the State. During the time so engaged his father and himself have originated three new varieties, all of which have been recognized as possessing considerable merit, and being better adapted for this locality than the varieties usually grown.

Before preparing this bulletin Dr. Stabler took a trip to Connecticut, and studied the methods of growing and curing as practiced there by the largest and most advanced seed growers, and the results of his observations are given herewith.

Reasoning from what has been accomplished in raising the sugar content with other crops, it is but natural to expect that sweet corn could be considerably improved in this respect, and this Station has started some preliminary work on this subject.

The facts, as set forth by Dr. Stabler, in the following pages, prove almost conclusively that Maryland farmers can not only grow their own sweet corn seed, but by doing so can, with reasonable care, improve the yield and quality of the corn, and get a more desirable crop in many other ways. Now if those engaged in the canning industry would give a little more detailed attention to producing seed there would be, no doubt, but that they could get a strain that for yields, sweetness and other qualities would place their business on such a basis as to put them in a class by themselves, and out of competition with the ordinary packer.

## INTRODUCTION.

The idea or tradition which has been widely circulated, that sweet corn, if grown south of Mason and Dixon's Line will become less sweet and tender, coupled with the fact well known to some of us, that a number of growers have been in the habit of saving their own seed in Maryland year after year for at least twenty-five years without any deterioration whatever, led to the prosecution of the following inquiry, in order that the best information obtainable should become the common property of all who desire to produce sweet corn for seed.

## MARYLAND VARIETIES.

In the family of the writer, and on the farm where he now resides, have been developed and kept pure three varieties of sweet corn, all recognized wherever grown as of the highest quality. On this farm the last seed obtained from the North was planted twenty-six years ago.

His grandmother had sweet corn in her garden which she saved year after year seventy-five years ago, in Montgomery county, Maryland.

In Carroll county, Mr. H. Wirt Shriver, has been planting and saving his own seed of Moore's Early Concord Sweet Corn for thirty consecutive years without change of seed. He and his neighbors think the quality is now better than it was originally. He is positive that earliness is favored by planting late—about July 4th—while sweetness is not affected by time of planting. He saves for his early planting the following year corn from the latest planting that will mature, and finds that by so doing he is able to keep it small and early. When he used to save seed from the earliest maturing ears of the early planting the corn became larger and later. He is evidently a very close observer, and the corn which the writer saw growing in his garden on July 20th was remarkably even and uniform, showing great care and patience on his part to select and breed to one uniform type.

The writer's father, the late Henry Stabler, always saved his own seed for canning, and developed several varieties that were then, and continue to be, as good as the best. He commenced his work with sweet corn about sixty years ago. He always said that sweet corn is as much at home in the climate of Maryland as it is anywhere, if selected to suit our conditions, and that a variety developed in this climate will do better here than one bred to suit a different climate; that sweetness depends on the kind of corn, and not on the climate. In selecting ears for seed he picked for the deep, narrow grain, well shriveled, having a translucent appearance, like amber when dry.

He also paid great attention to the developing of the productiveness of the corn, early recognizing that a corn having many rows of deep grain, fitting close together, would fill more cans to the acre than a corn with broad, shallow grains, and wide space between the rows of grain. He desired a corn having white silk and straight rows, as is shown in the following history of Roslyn Hybrid Sweet Corn, recorded in the writer's notes twenty-five years ago.

### HISTORY OF ROSLYN HYBRID SWEET CORN.

In the year 1878 the crop of sweet corn on Roslyn Farm consisted of about thirty acres, nearly half of which was planted from improved seed of Stowell's Evergreen, and the remainder was of the variety known originally as Burr's Mammoth, but which had been much improved by careful selection.

The object in planting the two varieties was to test their comparative merits for canning purposes. At the end of the season the question still remained somewhat in doubt, as each variety had shown certain points of superiority which the other did not possess. The Mammoth produced the longest ears; and this point, for canning, is one of great importance, since long ears are much more easily handled than short ones, and hence the cost of labor is reduced in the various processes of gathering, husking, silking and cutting from the cob. But the cob and foot stalk of the Mammoth were unnecessarily large, the

grain not proportionately deep, and the rows somewhat broken and irregular on the ear, thus making the corn more difficult to clean in silking. The Stowell's, on the other hand, while the ears were not quite so large, had much straighter rows, deeper grain, and a very small cob and foot stalk. It had been observed that those ears that possessed white silk were much easier to clean than those having silk of a dark red or brown, the latter being tough and wiry, and looking like hair, when mixed with the white grain, whereas the white silk was soft and brittle, and, being the same color as the grain, a small quantity of it was not noticeable.

Now it was found that in both Mammoth and Stowell's some ears had dark silk, but we were satisfied that by careful selection we might obtain a corn having all or nearly all white silk.

In the autumn of the same season, while selecting the stock of seed corn to be planted the following year, the thought occurred to me that a hybrid might be produced from the two varieties, which should possess the desirable qualities of each, and at the same time secure white silk. With this idea in view I kept my eyes open for extraordinarily fine ears of each variety, which should not only be larger than the average fine ears, but should be perfect in all respects, according to our standard.

Out of the entire crop I succeeded in obtaining five ears of Stowell's and seven of Mammoth, which satisfied all the requirements, many very large ears having been rejected because faulty in only one slight particular.

At planting time, in the spring of 1879, I shelled the five ears of Stowell's into one package, and the seven ears of Mammoth into another. Having selected a plot of excellent soil, well enriched, the rows were laid off four feet apart, and the corn was dropped in these one grain in a place every twelve inches. The first row was planted with Mammoth, the second with Stowell's, and so alternately until all the seed was planted, ending with a row of Mammoth. Thus each row of Stowell's had a row of Mammoth on each side of it. I proposed to save seed only from those ears that should grow on the plants of Stowell's. When the young corn obtained a height of about two feet I went along the row of Stowell's and carefully removed all the tillers, or side-shoots, leaving only the central stalk in each hill. As soon as these plants began to tassel, and before any of them had blossomed, I went over and removed all the tassels from the rows of Stowell's, leaving the Mammoth untouched.

Then was noticed a singular effect—the stalks of Stowell's that had all been topped, ceased to grow in height, but became much stouter, had broad dark green blades, and put forth ears in unusual abundance and of astonishing size. The plants had been deprived of the *male reproductive organs*, and hence were stimulated to greater development in other directions.

The ears which grew on the Mammoth were all pulled in the green state, and turned into the canning factory. The ears on the Stowell's, which were all fertilized from the Mammoth tassels, were allowed to

ripen, and turned out a very large proportion of beautiful, large, perfect seed ears, equal to, and many of them exceeding, the few choice ears planted. Some of them which were exhibited at the Montgomery County Agricultural Fair, in September, 1879, were awarded the first premium over all competitors for sweet corn. It had all the desirable points: *Large ear, straight rows, white silk, deep grain, small cob and foot stalk*; and at the same time a yield of ears exceeding that from any other rows in the field.

In the spring of 1880 three varieties of sweet corn were planted at Roslyn: Mammoth, Stowell's and Hybrid, each on separate plots of ground; but at the close of the season it was so perfectly evident to everybody that the Hybrid was superior to either of the others, or, in fact, to any variety of sweet corn previously known, that in 1881 no other was planted. A thirteen-acre field this year was estimated to have produced at the rate of eighty cases, or 1,920 two-pound cans to the acre. Fifty cases, or twelve hundreds cans, used to be considered a large yield of the old varieties, and only once before were they known to produce as much as 75 cases to the acre.

Care is taken each year to choose out a few of the finest ears in the entire crop. These are planted early, on a choice piece of land, and the entire product from these allowed to ripen. From this is selected the stock of seed to plant the crop of the succeeding year.

When "Egyptian" Sweet Corn was introduced, in 1878, Mr. S. N. Hyde, who now lives in Baltimore, began growing it, and saving his own seed; and by careful methods of selecting seed and packing of the product, built up an enviable reputation for high quality canned corn. In this connection the following letter from him is valuable testimony:

*Mr. H. J. Patterson,*

Dear Sir:—Your favor received. As regards the growing of good sweet corn in this State, I would say that for the last twenty-six years (except 1903) I grew all the seed corn for my canning business, and I never had to replant. I sold the corn, when canned, at a higher price than any canned in America.

I am now out of business.

Very truly yours,

Baltimore, January 25th, 1904.

S. N. HYDE.

In Harford county, the Baker's having been saving and planting their own seed about the same length of time—twenty-five years—the following notes of an interview with Mr. Chas. W. Baker afford valuable evidence that not only is this climate well suited to maintaining the good qualities of sweet corn, but that the seed may be saved here with far less labor and care than is usually required to cure reliable seed in the North.

Notes taken at Aberdeen, Maryland, July 23rd, 1904.

Mr. Chas. W. Baker has 500 acres of sweet corn growing for can-

ning. He has not changed seed for twenty-five years. He plants a special strain of small grained Evergreen, having narrow deep grains, developed from seed obtained originally from E. B. Clark, of Milford, Conn. It is sweeter than the large grained Evergreen, two-thirds as large, and just as early. To save seed, he sets aside certain rows in a field of good corn, and does not touch it at all until October, when the corn and fodder is all dead ripe. He then husks out the corn, allowing the fodder to waste, and spreads it thinly on a floor with plenty of ventilation, and allows it to remain there all winter. Just before planting it is shelled.

He pays no attention to any special characters, and does not breed or select, except to merely have the seed come from a field where the corn is a good crop of the right kind of corn. In the vicinity of Aberdeen are about 7,000 acres of sweet corn growing for canning this year. Nearly all of it is from home-grown seed of Evergreen and "Shoe Peg," these being the varieties most used by the Maryland canners at present. The packers do not want large-grained corn, because it is unsightly in the cans. There are no worms here, except in corn planted very late. They plant corn in check 3 1-2 feet square, and leave two plants in a hill.

It is cultivated mostly with two-horse walking cultivators. People in this section have found by long experience that if they do not save their own seed they cannot expect a good stand of corn. They never have had as fine a prospect for corn as this year. In a stretch of twenty miles along the railroad almost no other corn but sweet corn is planted. In canning, the whole grain is cut from the cob at one stroke, the silk is removed by a machine on the principle of a wheat fan, and the corn is packed straight without the addition of anything but water.

Most of the packers in the State of Maine add sweetening, which accounts for Maine corn being sweeter than Maryland corn. The development of useful varieties of sweet corn evidently has depended, and will depend more upon men and methods than upon climate. The experience at Aberdeen shows that there is no inherent tendency to deteriorate, if the variety be kept pure, and be grown under ordinary favorable conditions.

The recorded experience of experimenters with field corn of many varieties, at many places, all point to the fact, now generally accepted, that corn does best, *i. e.*, makes the largest yield of grain, when grown under climatic conditions similar to those where the variety or strain has been grown for a number of years. That in obtaining seed from a distance it is better to go East or West, rather than North or South, and to pay attention not merely to latitude, but to isothermal lines, altitude, fertility and depth of soil and humidity. A corn that has always been grown on low ground near the sea in a humid climate, and in highly-manured, intensely-cultivated soil—the conditions in Connecticut—will not produce as well on the high dry hill sides of Central and Western Maryland as a corn that has been grown and selected for a series of years to suit similar conditions.

In Harford county, Maryland, the climatic conditions during the growing season are very similar to those found in Connecticut, except that the season is a little longer, and hence more favorable to the curing of seed. In Connecticut the practice is to manure heavily all land in preparation for corn, and to keep up the cultivation until the corn is nearly matured. In Maryland these two great desiderata—manure and intensive culture—are often deficient in amount, and the mean relative humidity of soil and atmosphere is certainly much less in Western Maryland than in Southern Connecticut during the growing season.

*Normal Precipitation.*

| Stations.            | May  | June | July | Aug. | Sep. | Total. |
|----------------------|------|------|------|------|------|--------|
|                      | In.  |      |      |      |      |        |
| New Haven, Conn..... | 3.65 | 2.95 | 4.94 | 5.12 | 3.71 | 20.37  |
| Baltimore, Md.....   | 3.78 | 4.02 | 4.70 | 4.05 | 3.88 | 20.43  |
| Westminster, Md..... | 3.83 | 3.41 | 3.27 | 3.58 | 4.54 | 18.63  |
| Hagerstown, Md.....  | 2.55 | 3.87 | 4.54 | 2.77 | 1.85 | 15.58  |

*Mean Temperature.*

| Stations.            | May  | June | July | Aug. | Sep. |       |
|----------------------|------|------|------|------|------|-------|
| New Haven, Conn..... | 57.6 | 67.3 | 71.8 | 70.0 | 63.5 | ..... |
| Baltimore, Md.....   | 64.2 | 73.5 | 77.2 | 74.9 | 67.9 | ..... |
| Westminster, Md..... | 64.5 | 72.7 | 73.8 | 77.2 | 72.8 | ..... |
| Hagerstown, Md.....  | 64.4 | 72.7 | 75.3 | 75.1 | 69.4 | ..... |

\*The records for Westminster and Hagerstown are short and broken for some of the months, and hence do not give good normals.

The table shows that July and August, the months in which the corn planted in May is forming ears and perfecting grain, are relatively cool and moist in Connecticut, and comparatively hot and dry in Western Maryland.

In Connecticut most of the summer rainfall occurs in gentle showers, frequently repeated, that favor, rather than prevent, cultivation. In Western Maryland, while it is not exactly a dry climate, there are often, during the summer, very heavy storms, with two or three weeks of dry weather between, when the soil on hillsides becomes very dry, and cultivation is omitted for fear of injuring the corn.

A corn that has never had to stand such conditions curls up and stops growing much quicker than the deeper-rooted native varieties. Nor are these deep-rooted plants necessarily of poor quality, for the "Egyptian," which possesses great heat and draught-resisting power is one of the most sweet and tender of all sweet corns.

## MIXING.

In most farming sections of Maryland the greatest obstacle in the way of developing and keeping pure any variety of corn is the fact that many different varieties are apt to be planted in mixing distance of each other. Sweet corn and field, or hard, corn, if planted at the same time will mix at least a quarter of a mile away, and thus the sweet corn be much injured in quality. Adams' Early, which is not sweet corn, will ruin sweet corn blossoming near it at the same time. The conditions obtaining in Connecticut and Harford county, Maryland, are very favorable for avoiding this danger, for very little except sweet corn is planted in the sweet corn growing sections. But the writer has found little difficulty in avoiding the mixing by always planting sweet corn intended for seed a little earlier than any field corn is planted on his or adjoining farms.

The sweet corn is nearly always planted about April 15th to the 25th, and most farmers plant their field corn from one to three weeks later. Since the varieties of sweet corn that are most grown, with the possible exception of "Egyptian," which is very late, all blossom and mature quicker than any of the large growing field corns, there is no mixing, except with the latest ears on the sweet corn, and these can be readily detected, and thrown out when selecting the seed. This method of work in Maryland has been found to suit the soil climate and farm economy much better than the attempt to grow seed sweet corn by late planting after the field corn, though in this climate sweet corn of the earlier varieties will mature seed if planted July 4th. Stabler's Early, planted April 15th, is ready to eat July 15th, and ready to gather for seed about a month later. The weather in August is usually favorable for curing it, and the work can be done then without interfering with the harvesting of field corn and silage, which, after it once commences, keeps all hands very busy for two or three months. The sweet corn, if put into the corn-house before the field corn is cut, has plenty of time to dry thoroughly before freezing weather, and before the space is needed to store the field corn. For many years it has been the custom to select for home planting a small number of ears having the characteristics most desired. Earliness is maintained only by saving the earliest ears from the early corn, and from these earliest ears a small number, known as "double extra," are set aside for the breeding plot. In selecting these double extra ears attention is not only paid to size, length of grain and length of cob, but for the character of the corn for quality, as denoted by its translucent appearance. Effort is made to practice RIGID SELECTION, *i. e.*, not only to have a great many of the right kind of ears, but to plant none of the wrong kind in the breeding plot or near it. When the corn gets ready for the table do not allow those who are gathering corn for dinner to go all over the breeding plot and pluck the first maturing ears. Set aside a few rows for eating, and leave the rest for seed, with the earliest ears untouched. The reason why corn becomes later in Maryland is because something so often happens to the earliest

ears. All sweet corn has a tendency to throw out side shoots, or suckers, from the crown, which do not bear good ears, but which absorb much of the nutriment which should go into the ears. If these suckers are removed about the time the grain is forming, no more suckers will be thrown out. The ears will be finer, and will receive more sun and air while maturing. The suckers, which are readily snapped off by a quick pull, make excellent feed for soiling cattle or hogs. While removing suckers it is my custom also to remove all barren stalks, so that nothing is left in the breeding plot but plants with ears on. At a later date we go over again and cut for the hogs or cows, as they require all plants bearing nothing but nubbins, or small ears, so that when the crop is mature enough to house we have nothing to handle but the plants bearing the large ears.

### METHODS OF CURING.

The writer's methods of curing sweet corn for seed has been developed after many trials and vexatious failures from following other and more laborious methods, and is given with the confident knowledge that up to the present time it is the best method devised yet to save feed and fodder at the same time. Since adopting it there have been no failures. When the husk is dead and loose on the ear, the sooner the ear is removed and put under the shelter the better, for two or three days of rainy, not cloudy, weather, may spoil it, even on the stalk.

I pick out a bright clear day, and commence early in the morning and cut down a small piece of the corn, throwing into piles, and then in the forenoon, when the sun is shining brightly, husk it out as rapidly as possible, throw the corn into small piles on the ground, tie the fodder in bundles, and set it up in small shocks. Then before night haul in the corn and put it on a slatted floor. The floor is made of lath one inch thick by two inches wide, spaced one-inch apart. The corn is taken up in baskets, and each basket is turned upside down on the slats, and taken off carefully, so that the ears are left like a pile of "jack-straws," crossed in every direction, many of them standing in nearly a vertical position. Each basketful of corn is emptied in a fresh place, and when all is done the slats will be covered with corn about a foot deep, but so loosely arranged that there is no obstruction to the passage of air between the ears. In this position it dries very quickly, and may be put into barrels as soon as all moisture is out of the cob. Each barrel may be covered with a piece of wire cloth held down by the top hoop, and then the barrel turned on its side.

In Connecticut the method of securing seed corn is antiquated, and requires more careful handwork than is necessary. All the growers practice one method, as follows:

When mature the stalk is topped above the ear (old Virginia way), and the husk is stripped carefully down without breaking off the ear. In this position it is allowed to stand for two or three weeks, and furnishes a grand feast for blackbirds that like corn. When nearly dry it is gathered and stored in the seed barn on slatted crates, that are

used later to hold onion sets. These frames are nailed on to end pieces 1 in. by 6 in. by 3 1-2 ft. The crate complete is 3 1-2 ft. by 4 ft. and five inches deep, with middle piece 1 in. by 1 in. by 3 1-2 ft. across the bottom two feet from each end. On these crates the ears are placed not more than three ears deep on each crate. Scaffolding of 2 in. by 4 in. scantling supports, successive tiers of crates one above another, so that the bottom of one tier of crates is two feet above the bottom of the one below it, allowing about one and one-half feet air space between each two layers of corn. The floor under this is a tight one, and all the air that circulates through the corn has to come from the small windows in the sides of the seed barn, which are open while the corn is drying. A plan for drying stored grain, which the writer saw in successful operation on the farm of the inventor, Mr. Henry Warden, Fredericksburg, Va., is applicable to sweet corn, onions, or other coarse seeds, as well as to corn, wheat or oats. In answer to a request for a detailed description he has written the following:

The idea is to have a practically air-tight bin, with a false bottom about six inches above the main bottom or floor. The false bottom is supported on 2x6s, placed on edge, about 10 or 12 inches from centre to centre; across the top of these, and at right angles, are secured strips 1 in. by 2 in., spaced about 1 in. apart; on top of these is placed wire cloth, such as is used in window and door screens. The 2x6s are so cut as to permit a free circulation of air between the bottom and false bottom. Connected with the space between the bottom and the wire cloth is a fan, by means of which air is forced through the stored grain. Three years ago, during the summer of 1901, we had a great fall of rain, in July—I believe over 6 inches—and much of the small grain was damaged in the shocks. We threshed oats that were so wet that all would not drop out of the weighing hopper, and few would pass from the bagging hopper; it was necessary to have a man stand at the latter, and force the oats into the bags. Only the first of the oats threshed were so wet as this, though all were more or less damp, and none in condition to keep without heating. All these oats were placed in a wooden tank, 14 ft. in diameter by about 19 ft. high—that is, above the false bottom, the wettest being first placed in the tank. I do not think the fan was operated on these oats more than three hours, yet, the results were perfectly satisfactory. Wood & Co., of Richmond, Va., purchased them for seed, and no complaints were ever received by me from them; and those at the bottom of the tank—the ones that had been the wettest—I used for my own seed, and while they were heated a little (a thing which I think could have been prevented had the fan been used an hour or two longer), we secured a most excellent stand.

It is my intention to construct all of my grain storage bins on this plan, building them of concrete steel, as I believe this will be better than any wooden construction that can be made, aside from the safety from fire. I believe it can also be shown that such construction is as cheap, if not cheaper, than an equivalent one of wood.

The advantages of such a bin are manifest; the grain can be kept

free from weevils, rats, etc., if provided with an insect-proof top, and the newly-stored grain can be treated with an insecticide to kill all injurious worms and insects.

The tops of the grain tanks are open under the roof to allow the draft to pass freely up and out. The blower used was an exhaust fan No. 4, made by the Champion Blower and Forge Company; this, according to the table published by them, delivered 1138 cubic feet of air per minute, at a pressure of 2 1-2 ounces, consuming 1.11 H. P., at a speed of 2147 revolutions per minute, which is about the speed at which we operated the fan. This proved sufficient to dry the oats in a tank 14 feet in diameter, there being 16 feet of oats in the tank.

For drying corn in a bin, such as mine is, an ordinary wheat fan of fair size would doubtless be sufficient, owing to the fact that very little pressure would be required to create and maintain the current. It draws like a chimney. The grain in the tank being slightly warmer than the outside air maintains an upward draft, which once started, never stops till the grain is all dry and cool. The wind, if the top and bottom be properly constructed, will also make a strong upward draft through the bin.

In a corn-house such as he describes the slat crates as used in Connecticut can easily be put in on temporary scaffolding to dry the sweet corn, and the corn left in position until spring without fear of mice, rats or insects disturbing it, or it can be packed in barrels, when dry, and the space utilized to store hard corn later, or onions if desired.

## CAUSES OF IMPERFECT GERMINATION.

These are first *fermentation* and second *freezing*.

The first cause is the one most likely to cause damage in the South, the second, freezing, is most to be feared in the North. While in Connecticut the writer was told by several prominent growers that corn which is planted later than May 25th does not get mature and dry enough before freezing weather, and hence is unreliable as seed. Seed which has been injured by freezing looks just as perfect as any, and hence, is so often purchased and planted by unsuspecting growers. Seed which has been heated, or is sour or mouldy, is easily detected by simple inspection. Fire heat used to dry the corn has not proved satisfactory, because it will cause the cob to sour long before it has had time to dry out. Corn thrown in a large pile with or without the husk on, will develop heat enough inside of twenty-four hours to injure the germ, sour the cob and discolor the grain. Sweet corn cut and shocked up like field corn will sour before it dries, unless the weather be both cool and dry enough before winter to escape injury by freezing. Corn left on the stalk untouched until the husk opens will be greatly discolored and injured by a spell of hot, damp weather. If, however, the ears be husked out on a dry day, and allowed to lie a few hours exposed to the direct rays of the sun, the organisms which cause fermentation are killed by the sunshine, and a layer of dried impervious matter is

formed over the surface of the corn and the butt end of the cob, which makes it more difficult for fermentation to start in either corn or cob.

If the corn, which has thus been partially dried in the sun, be taken at once under shelter, and arranged so that there is a continuous draft of cool air through it night and day, it continues to dry without heating or moulding, and is ready to pack in barrels before the field corn is ready to be stored in the same space. Warden's device therefore fills all the requirements of an ideal building to dry sweet corn according to the method which has given such uniformly good results on the writer's farm.

## OPPORTUNITIES AND ADVANTAGES IN GROWING SEED IN MARYLAND.

It is evident from what has been written that not only is it desirable to save seed sweet corn in Maryland, in order to obtain and perpetuate stock suited to the climate, but we have a climate better suited to maturing and curing the crop than even the Connecticut experts can boast of. It is desirable, however, that the work should be entrusted to trained experts for the development, improving and maintaining of a pure and useful breed of corn is a work of art that demands not only creative ability, skill and judgment, but faithful continuance in one line of work, and unlimited patience to wait for results. The reason why more of our bright young men have not taken up this line of work is evidently the mistaken notion so industriously circulated by Northern people that corn loses its sweetness when grown in the South. Grocers will tell you that the sweetest canned corn comes from Maine, but the secret has leaked out that the Maine packers always add sweetening. The Connecticut growers of seed for the Maine canners are encouraged to select the corn for whiteness and tenderness rather than sweetness.

The Country Gentleman Corn, which originated in Connecticut, and is so much used by canners, is white and tender, and has a long, narrow grain, but is inferior in sweetness to either "Egyptian," Stabler's or Stowell's.

The long stand, or evergreen quality, is one not especially desired by canners, for they like to have the entire crop of one planting to be ready nearly at the same time. This quality is almost incompatible with extreme earliness, for earliness is only obtained by selecting ears for seed that mature quickly, and perhaps also by late planting, as practiced by Mr. H. Wirt Shriver. The latter method is not applicable in the North, because of the danger of freezing, and has not been tried by large growers anywhere, so far as I have been able to learn. It may be that second crop seed corn will be as much in demand in the near future as are now second crop seed potatoes grown in Virginia and Maryland.

Large size is not altogether incompatible with a fair degree of earliness, for Stabler's Early grows eight or nine feet high, and is

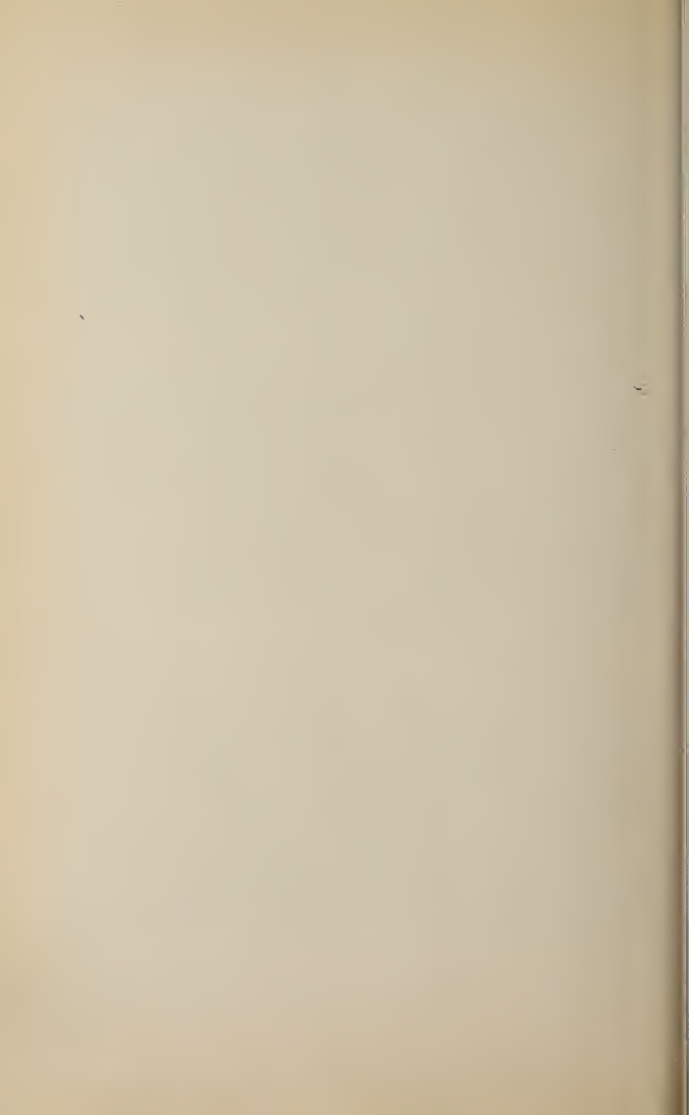
ready to eat in ninety days after planting, and the ears are now fully as large as Stowell's.

An early corn with large ears and large fodder is especially valuable to those market gardeners who are also dairymen and keep hogs, for the ears will usually sell in market for a good price, and leave a good quantity of valuable fodder to feed in July and August, when pastures are generally short, and when field corn, millet, sorghum, or cow-peas are all too immature to make good feed. Sweet corn may be planted thicker than field corn; it suckers freely, and if fed green, the whole plant is greedily consumed by the stock. A careful dairyman in Montgomery county states positively that he can make more milk from an acre of large, sweet corn fed green to the cows than from a similar acre of field corn. It also makes the best of silage, so that a man having cows and a silo need not fear to plant a good acreage in sweet corn, if only he can obtain reliable seed at a reasonable price. Farmers have been discouraged from planting it for fodder, because the seed has been very costly, and much seed on the market was utterly worthless for any such purpose. There are some large growers of sweet corn in the State who sell the ears to the canning factories, and make silage of the fodder. If cow-peas be planted with the corn, or even the old-fashioned corn hill beans, the silage will be increased in quantity and improved in quality without detriment to the ears, and with a decided increase in the nitrogen and humus left in the soil for succeeding crops. Cow-peas do not grow well in Maryland, if planted earlier than May 25th, but may be combined with any plantings of corn made between that date and July 4th. Corn Hill beans succeed best when planted with the early corn—April 24th to May 25th—and will grow better and have more effect as land improves, if planted year after year on the same land.

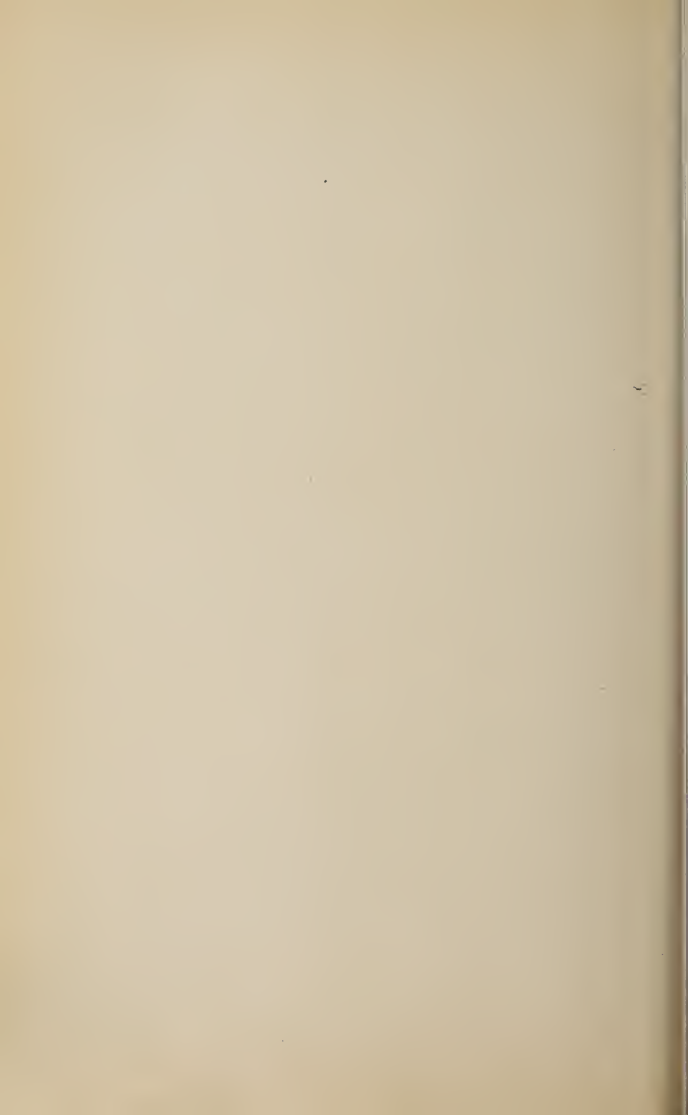
### MAINTAINING FERTILITY.

All varieties of corn delight in rich land, and to this rule sweet corn is no exception; but owing to the fact that it does not grow as tall as the field corn, catch crops of leguminous plants, like crimson clover and cow-peas, make a much finer growth in sweet corn. If one of the large late varieties of cow-peas, like Wonderful, be planted between the rows of early sweet corn, at the last working, the pea vines are just in condition to make their best growth after the corn matures, and generally make a very fine growth before frost.

The writer has a one-acre plot in young orchard that has been in sweet corn and cow-peas thus for ten consecutive years, without rotation, and with only light dressings of cheap fertilizer: The corn crop is apparently as good as ever, except that the trees are now so big as to nearly occupy the ground, and I shall have to cease growing crops between them.







# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

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Bulletin No. 97.

October, 1904.

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## The Relative Profits of Selling Milk, Cream and Butter.

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By C. F. Doane.

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Owing to Maryland's geographical position, in reference to the large and growing cities of Baltimore, Washington and Philadelphia, there will always be great opportunities for disposal of all classes of dairy products, and this demand will probably always make dairying take a leading and prominent part in the agriculture of the State.

With present conditions, the milk and cream supply of these cities will come preferably from the nearby sections, and thus, the farmers who are in position to furnish these products do not have to fear the competition of distant sections, even though they may be more favorably located, and can produce milk and cream much cheaper.

In Maryland there are opportunities for all classes of dairying, but, of course, the one which is best for any one person to engage in will depend to a great extent upon the local conditions. The milk and cream trade is more circumscribed than the making of butter, from the fact that the supply and demand is dependent upon the daily consumption, and if any surplus exists it must be utilized at once in some other way, or be a loss.

The question of what kind of dairying is best to pursue is often asked, not only by those thinking of engaging in this class of farming, but also by those now in the work, but who are in doubt as to whether the particular branch they are following is giving as much returns as it is possible to obtain.

With a view of giving some definite data to guide those seeking information on these points, it was decided to make a study of the conditions surrounding the dairy industry of Maryland, and obtain some definite data as to the prices being received for the different products at different times in the year. The matter given in the following pages is the result of such a study. The data was obtained by going to many parts of the State, and having personal visits and interviews with those engaged in different branches of dairying. The Experiment Station is deeply indebted to those who have given the information asked and extended in many ways help and other courtesies, and thus made possible the placing of this data in the hands of all interested in this subject. It is hoped that the facts set forth may result in a better understanding between those engaged in different branches of dairying.

## KINDS OF DAIRYING CONDUCTED IN MARYLAND.

Three distinct lines of dairying are conducted in this State. The most important is producing milk for the cities. Next in importance is the making of butter on the farm, and the third is the creamery butter industry. These various branches of industry do not seem to be confined to distinct and well-defined sections. Farmers living near the railroads are more likely to ship than are those living at a distance from shipping points. But the State is well supplied with railroads, and milk shippers are found in almost every community, and at the same time, some home butter-makers and farmers sending milk to the creameries.

## THE SHIPPING OF MILK AND CREAM.

The supplying of milk and cream to the city trade is the most important dairy interest in Maryland. There is likely to be a constantly increasing demand for milk and cream in the cities corresponding to the increase in population; and to this extent there are opportunities for the growth of this kind of dairying. Again, there could probably be considerable done towards increasing the consumption of milk, by improving the quality of the product.

The opportunities for shipping milk and cream are, as a rule, confined to those localities within a short radius of the city, and to farms comparatively near the railroad; yet, it is not uncommon to find persons engaged in this kind of dairying who live three to four miles to the shipping point, and, in some cases, milk has been shipped to both Baltimore and Washington from Northern and Western New York. Most of the milk for Baltimore and Washington comes from points within a few miles, and very few regular shipments from a greater distance than 50 or 60 miles; yet, it is a regular thing for milk to be shipped to New York City from 200 to 300 miles. From these facts it will be seen that the territory from which it is possible for a city to draw its milk supply is not necessarily as circumscribed as is commonly considered. Of course, other things being equal, the nearer the sources of supply the better should be the condition of the milk when it is placed in the consumer's hands.

## THE SELLING OF MILK TO CREAMERIES.

The creamery industry in Maryland is in some respects quite different from that found in the West, inasmuch as most of those in this State do not confine themselves to the making of butter, but make butter only as a means of utilizing surplus, and sell most of their products as cream or ice-cream. The selling of the products of creameries for cream and ice-cream, rather than the making of it into butter, has enabled the farmer to realize better prices than would be obtained otherwise. Some creameries of the State that have made all of their products into butter have been run quite successfully, while many have been a disappointment to the farmers, and could not hold their patronage because of the low prices paid for milk. A part of this failure can be attributed to the quality of the products turned out. The reason for a poor quality of butter is no doubt due to a number of causes distributed among the creamery and its patrons. The creameries, in many

cases, have not only given the farmers better prices for their products, but also have required less labor at home. This work usually fell to the lot of women, as, in fact, does the greater part of dairy work in some sections of the State. Butter making is a severe tax on the time and strength of most women, and most of them are rightfully glad to get rid of their work. In the great creamery districts of the West the creamery was welcomed for two reasons: As a rule, a better article was made than could be made on the farm, and this enabled the creameries to pay better prices for the milk than the farmer could realize by making butter on the farm. But perhaps the greatest welcome was given to the creamery because it released the housewife of a heavy burden. This is a consideration on many Maryland farms, but the writer must say that in most cases before the creamery could be assured of the patronage of the milk producer it had to show him that he could realize more for his milk than he could realize from the older system. This rather forced the conclusion that the work of the women was not valued at anything; or, perhaps, to put the matter in a little better form, it was not considered of any value to relieve the women of the extra work. The best that can be done is to put the cost of labor in making butter on the farm against the cost of hauling the milk.

### HOME BUTTER-MAKING.

There is considerable butter made on the farms in Maryland, and much of it commands a very good price; in fact, in many cases, more than can be realized from creameries. There are many opportunities for farmers to have special and private trades for home-made butter. The butter made on the farms is sometimes of very good quality, as the number of springs in the State give excellent conditions for the proper care of dairy products. The tendency, however, is towards disposing of the milk and cream in other ways, whenever it is possible, as the methods make less labor on the farm. There will continue to be considerable home butter-making in the isolated districts, and also by those who can sell their butter at good prices to private trade and to hucksters.

In discussing the merits of these different branches of dairying there are very many points to be considered, such as the value of the by-products, the cost of hauling, and a number of others which enter into the profit of the industry, but which in a measure have an indirect bearing, and which vary considerably from farm to farm, so that it will be impossible to make definite allowances for these in this bulletin. The value or cost to be attached to each of these can be estimated fairly well by each farmer for himself, and thus enable him to adjust the facts given in this bulletin to meet his individual case.

### SKIM MILK.

The skim milk should be considered in making prices received for the milk. Of course in shipping milk to the city trade no skim milk is available for the farmer. In shipping cream all of the skim milk is available. In hauling milk to the creamery, as a rule, the skim milk is returned to the farmer, though this is not invariable. In some cases

only a part of the skim milk is returned, while in other cases, when an unusual price per pound was paid for butter fat the patrons were charged at the rate of one cent per gallon for the skim milk. It is very difficult to put a price on the value of skim milk. For raising young calves it is almost indispensable, and could well be worth 40 cents per hundred. For fattening grown hogs it is worth ten to fifteen cents per hundred, while for growing pigs it is easily worth twenty cents per hundred. Most farmers could easily realize this amount on their skim milk.

### EXPENSES OF TRANSPORTATION.

The cost of shipping milk plays an important part in calculating the actual price received. These charges vary with the different roads carrying milk to Baltimore and Washington, and with some of the roads the charges vary with the distance hauled. The Baltimore and Ohio road hauls milk to Baltimore from two directions, and charges a uniform rate of seven and one-quarter cents for a twenty-quart can, and fifteen cents for a forty-quart can, the charges for milk and cream being the same. The Maryland and Pennsylvania road charges twenty cents per forty-quart can for both milk and cream for all distances. The Western Maryland, within fifteen miles of Baltimore, charges ten cents per forty-quart can of milk. From Glyndon, which is nineteen miles, are twenty-five cents per forty-quart can. Beyond fifty-one miles the charges are thirty cents per forty-quart can. The amount of money received by the farmer for his milk is, of course, the price paid by the city dealer, less the transportation charges.

The only railroad which hauls milk from Maryland territory to Washington is the Baltimore and Ohio. The charges within thirty miles are twenty-five cents per forty-quart can. Beyond fifty-one miles the charges are thirty cents per forty-quart can. The amount of money received by the farmer for his milk is, of course, the price paid by the city dealer, less the transportation charges.

### COST OF HAULING MILK TO DEPOT AND CREAMERY.

Another item which must be considered in determining the comparative profits of handling milk is the cost of hauling it to the creamery, or the shipping point. The most satisfactory way to arrive at this charge is simply in taking the prices charged by milk haulers that can be found at most every creamery. Strange to say, no instance was discovered of a single hauler taking the milk from a number of farms to a railroad shipping point, the individual farmers seeming in all cases to haul their own milk. This could likely be accounted for by the fact that the milk trains run so early in the morning that the time of milking and the time of delivering the milk are not far enough separated to allow a wagon to drive from farm to farm gathering up the milk of different shippers, as can be done when the milk is sent to a creamery. In the latter case the milk does not necessarily need to be delivered before nine o'clock, while the milk trains usually start at six o'clock.

The prices of hauling milk to creameries were secured, and were found to vary from ten to twenty cents per hundred pounds of milk, the skim milk being returned free of charge. In many instances the milk was hauled a distance of five miles or more, and, as far as could be determined, the same price was charged for hauling the five miles as two miles. The actual cost of hauling milk to railroad shipping points will depend on a number of conditions. If the farmer has to do the work himself and uses his team, or his team is kept from the field during his absence, the hauling of the milk is worth the time of a man and team for the time required in getting to and returning from the shipping point. In this case, there would be periods, during the busiest season of the year, when it would be an actual hardship to take from the farm work the necessary time to haul the milk. On the other hand, during periods of slack work, the time of a man and team is worth very little. In many cases a small boy and an old horse are utilized for hauling milk, and this is even cheaper than the ten cents per hundred paid to the creamery haulers. On the whole twenty cents per hundred pounds of milk is a pretty liberal allowance, considering the fact that most of the hauls are short.

### COST OF MACHINERY AND DAIRY UTENSILS.

There is, of course, necessity for considering the amount of money that will need to be invested in machinery and utensils under the various systems. Where any large amount of milk is turned into butter on the farm the necessary complement of creameries, pans, churn and worker will cost about the same as cans for shipping milk. In sending milk to a creamery a sufficient number of cans to hold all the milk produced in one day is all that will be required. For shipping milk to the city to the most responsible dairies three sets of cans are needed, and these very naturally represent considerable of an investment. The best cans should last five years, so that the number would need to be renewed every five years. In shipping milk to some of the less responsible dairies, so little regard is shown for the rights of shippers that instances are related where an entirely new set of cans would have to be purchased every year. Some of the dairies ship milk to Southern cities, and they do not hesitate to use their patrons' cans for this purpose. These cans may or may not be returned. As this class of dairies is always the one to pay the lowest price per gallon to the producer, it can be seen that the lot of the producer is not an enviable one. It is likely that a can would be used about one hundred times during a year. For the best five-gallon can, three dollars would be a liberal allowance. This can should last five years. This would mean that it would carry 2,500 gallons of milk, which would make the cost for cans one-eighth cent per gallon of milk shipped, or about one and one-half cents per one hundred pounds of milk shipped. Under conditions of less responsible dairies it might be as high as four or five cents per hundred pounds of milk shipped.

### EFFECT ON FERTILITY.

In considering the various items which affect the relative profits in various lines of dairying, it must not be forgotten that the shipping

of milk to the city is a greater drain on the fertility of the farm than where the skim milk is used for feeding purposes, and a relatively large per cent. ultimately finds its way back to the soil in the form of manure

### COST OF CARING FOR MILK.

Another disturbing factor in comparing prices realized for milk is in the extra expense of handling. The city dairy demands that the milk received be sweet, while the creamery is not so particular as to the condition, though it should be. On the other hand, it would appear that for farm butter-making milk and cream should be handled with as much care and more labor than when intended for the city supply.

### SURPLUS MILK.

One of the things which operates to the loss of shippers of milk to the city is the over-production of milk in the summer as compared with winter.

During the summer practically every dairy has a surplus of milk, due to the shortsightedness of producers in general, who find it impossible to get over the old and mistaken idea that cows should come fresh in the spring instead of the fall, and to the fact that a large portion of the city population is gone for the summer. It is a difficult matter to get at any satisfactory basis of the loss incurred by the fact that there is such a surplus. Where an honest dealer comes out fair and square, and tells the producers that he can only take a certain quantity of milk, there should be no loss that could be considered in their comparison of profits, for the surplus could be made up into butter, and disposed of at prevailing prices. But many irresponsible dairies are much inclined to prevent surplus by returning a few cans of milk to some of their shippers, making the claim that it was sour on arrival. Milk thus returned comes near to being a dead loss to the shipper, as it is unfit to make butter from. Still, other dairies have a system of rebates on the surplus, paying the agreed price for all milk that they can use in their regular trade, and for the surplus paying about what can be realized for it. This is a fair arrangement when understood by all parties concerned, and when honestly administered by the city dealer. It can be seen, however, that there is a chance for gross misrepresentation as to the amount of milk required for the regular trade. The arrangement, which is at least open to criticism, is for the dealers to notify the shippers how much milk to ship, allowing the shipper to dispose of the surplus to suit himself.

### SUMMER AND WINTER DAIRYING.

The question of a summer surplus of milk naturally leads into the very important question of the relative merits of summer and winter dairying.

There is considerable more milk produced in Maryland during the summer months than during winter. The reason for this is due, to some extent, to the old and prevalent idea that cows coming fresh in the spring will do better than those calving in the fall. This idea is

probably erroneous as far as shown by results of recent observations; yet, there is a preference by many for summer dairying as at that season, it is easier to take care of the calf, if it is to be raised, and pastures are abundant; and it is easier, and sometimes cheaper, to feed cows during summer rather than winter. These facts are no doubt true, for the farmers who are making dairying only a side issue, and are conducting the general farm operations with a minimum of labor. For those who are making dairying the main thing on the farm, and who are endeavoring to conduct it on an extensive system, it is doubtful if summer dairying would be as profitable as winter.

The amount of milk available for city supply in winter is generally below the demand, while in the summer there is much more than is desired. This condition has caused an abnormal state of affairs in that many city dealers often take milk which they really do not need in order to hold the shipper and get milk in winter. This state of affairs makes the yearly average price lower than would be paid by many dealers, if they could be assured of an abundant supply in winter, and would not have to take any more in summer than was actually needed. It will be noted that the data obtained in this investigation, as given in tables one and two, pages 52 and 53, shows better winter than summer prices for dairy products. These results would seem to indicate that winter dairying is more profitable than summer; yet, the factor of the relative cost of production must be taken into account, and as the cost varies with different farmers, each person will have to determine the relative net profits from the data which covers his own individual case.

### BASIS FOR PAYING FOR MILK.

In studying this question, and in deducting safe conclusions, there are many difficult points to be handled. The value of milk for butter-making depends entirely upon its fat content. Creameries buy milk on this basis, paying so much for the fat the milk contains. But, on the other hand, no city dealers pay a price depending on the fat content.

At one time the Filston Dairy, of Baltimore, Maryland, paid for its milk according to the amount of fat it contained, but this dairy changed hands, and the practice was discontinued. The Pikesville Dairy, of Baltimore, at the present time, applies a gravity test to their milk, this being a crude way of determining the fat content, and they pay for the milk on this basis. In a few dairies, both in Baltimore and Washington, the milk from the different shippers is tested occasionally to see that it is coming to the required standard, but milk containing six per cent. of fat will bring no more than milk with four per cent. of fat. A few dairymen profess to pay a better price for a high-testing milk, but in no case, unless the Pikesville Dairy, of Baltimore, be an exception, is milk shipped to the city, paid for on a fat basis.

The same is practically true of cream. The city markets demand cream containing twenty per cent. of fat. But the cream actually shipped to the cities varies both ways from their standard. There is undoubtedly cream shipped to both Baltimore and Washington that contains not more than fifteen per cent. of fat. On the other hand, producers

who have separators, and do not know how to regulate them, ship cream that often contains more than twenty per cent. of fat. Some of the dairies would much rather have milk than cream, preferring to do their own separating, and thus get a uniform article.

The following tables show prices paid producers for milk per gallon by Baltimore and Washington dairies, and the price for butter fat by different creameries throughout the State:

*Price per gallon for milk paid producers by Baltimore dairies.*

| Dairy.  | Winter<br>Price of Milk<br>per Gallon. |         | Summer<br>Price of Milk<br>per Gallon. |         | Winter<br>Price of Cream<br>per Gallon. |         | Summer<br>Price of Cream<br>per Gallon. |         |
|---------|--|---------|--|---------|---|---------|---|---------|
|         | Max.                                   | Min.    | Max.                                   | Min.    | Max.                                    | Min.    | Max.                                    | Min.    |
| A ..... | 18 cts.                                | 17 cts. | 16 cts.                                | 15 cts. | 75 cts.                                 | 70 cts. | 70 cts.                                 | 65 cts. |
| B ..... | 17 "                                   | 14 "    | 14 "                                   | 13 "    | 70 "                                    | .....   | 55 "                                    | .....   |
| C ..... | 18* "                                  | 14 "    | 13 "                                   | .....   | 85 "                                    | .....   | 75 "                                    | .....   |
| D ..... | 20\$ "                                 | .....   | .....                                  | .....   | .....                                   | .....   | .....                                   | .....   |
| E ..... | .....                                  | .....   | .....                                  | .....   | .....                                   | .....   | .....                                   | .....   |

*Price paid per pound of butter fat by creameries in Baltimore Territory.*

| Creamery. | Winter. | Summer. | Disposition of<br>Skim milk. |
|-----------|---------|---------|------------------------------|
| A .....   | 30 cts. | 20 cts. | Returned.                    |
| B .....   | 25 "    | 16½ "   | Returned.                    |
| C .....   | 22 "    | 20 "    | Returned.                    |
| D .....   | 25 "    | 20 "    | Returned.                    |
| E .....   | 29 "    | 23 "    | Returned.                    |
| F .....   | 24 "    | 24 "    | Returned.                    |

\*Paid to those who agree to deliver milk in winter only, and dispose of milk some other way in summer.

§This price is doubtful, but is given for what it is worth.

Dairies D and E both seemed to be very secretive about their business.

*Prices paid producers per gallon of milk and cream by Washington Dairies.*

| Dairy. | Winter Milk. |         | Summer Milk. |         | Winter Cream. |         | Summer Cream. |         |
|--------|--------------|---------|--------------|---------|---------------|---------|---------------|---------|
|        | Max.         | Min.    | Max.         | Min.    | Max.          | Min.    | Max.          | Min.    |
| A..... | 17 cts.      | 17 cts. | 13 cts.      | 12 cts. | 65 cts.       | 65 cts. | 55 cts.       | 50 cts. |
| B..... | 18 "         | 18 "    | 12.5 "       | 12.5 "  | 60 "          | 60 "    | 55 "          | 55 "    |
| C..... | 18 "         | 16 "    | 14 "         | 12 "    | 65 "          | 65 "    | 55 "          | 55 "    |
| D..... | 18 "         | 16 "    | 13 "         | 12 "    | 65 "          | 60 "    | 55 "          | 55 "    |

*Prices paid per pound of butter fat by creameries in Washington Territory.*

| Creamery. | Winter. | Summer. | Disposition of Skimmilk. |
|-----------|---------|---------|--------------------------|
| A.....    | 35 cts. | 23 cts. | Returned.                |
| B.....    | 23 "    | 17 "    | Returned.                |
| C.....    | 22 "    | 17 "    | Returned.                |
| D.....    | 27 "    | 20 "    | Returned.                |

With the foregoing tables it is possible to figure out which is the most profitable kind of dairying. The maximum and minimum prices are based largely on the quality of the milk. The better dairymen are willing to pay an increased price for a good article, and milk comes to the market in most all kinds of conditions; it should, and does, to some extent, command all kinds of prices.

The prices paid by the creameries are hardly based on a strictly wholesale butter market. There are very few creameries in the State at the present time making butter, except to work up a surplus. The others are forced to find a more profitable outlet for their product than can be found in the butter market. One large creamery near Baltimore had worked up a semi-private trade for print butter in Philadelphia, and got a little better than the wholesale market price. Another near Frederick is run in connection with a retail butter and egg store in Baltimore, and can afford to pay more for milk than otherwise. Most of the creameries either ship cream or make ice-cream. The ice-cream business, as ordinarily conducted by the country creamery, is very profitable, as a not very good article is manufactured and sold for comparatively good prices in small towns and to picnics.

The prices paid for butter North and West of Baltimore are to some extent artificial. The huckster business has been so overdone that there is lively competition, with the result that the farmer benefits very largely. The one case spoken of where a private butter trade at thirty

cents per pound throughout the year, was, of course, comparatively profitable. But there was considerable work attached to making and delivering this butter. It is very good butter. It costs about four cents per pound for making, and fully four cents a pound for delivering. There is, however, an overrun of one-sixth, which would make a little better than twenty-five cents a pound for butter fat.

The following table gives the value of milk for different tests; also of butter fat and butter when the price and the test of the cream are given:

*Comparative Prices of Milk, Cream, Butter-fat and Butter.*

| Cream<br>Per Cent<br>Fat | Price<br>per Gal. | 3½% Milk. | 4½% Milk. | 5½% Milk. | Butter Fat<br>per lb. | Butter<br>per lb. |
|--------------------------|-------------------|-----------|-----------|-----------|-----------------------|-------------------|
| 20                       | 50 cts.           | 12 cts.   | 14.5 cts. | 17 cts.   | 28 cts.               | 23.5 cts.         |
| 20                       | 55 "              | 12 "      | 15.5 "    | 18 "      | 31 "                  | 26 "              |
| 20                       | 60 "              | 13.5 "    | 16.5 "    | 19.5 "    | 34 "                  | 28 "              |
| 20                       | 65 "              | 14.5 "    | 18 "      | 21 "      | 37 "                  | 31 "              |
| 20                       | 70 "              | 15.5 "    | 19 "      | 22 "      | 40 "                  | 33 "              |
| 22                       | 50 "              | 11 "      | 13 "      | 15 "      | 25 "                  | 21 "              |
| 22                       | 55 "              | 12 "      | 14.5 "    | 17 "      | 28 "                  | 23.5 "            |
| 22                       | 60 "              | 13 "      | 15.5 "    | 18 "      | 31 "                  | 26 "              |
| 22                       | 65 "              | 13.5 "    | 16.5 "    | 19.5 "    | 33.5 "                | 28 "              |
| 22                       | 70 "              | 14.5 "    | 17.5 "    | 20.5 "    | 36.0 "                | 30 "              |
| 22                       | 75 "              | 15.0 "    | 18.5 "    | 22.0 "    | 39.0 "                | 32.5 "            |
| 25                       | 55 "              | 11 "      | 13 "      | 15.0 "    | 25 "                  | 21 "              |
| 25                       | 60 "              | 11.5 "    | 14 "      | 16.5 "    | 27 "                  | 22.5 "            |
| 25                       | 65 "              | 12.5 "    | 15.0 "    | 17.5 "    | 29.5 "                | 24.5 "            |
| 25                       | 70 "              | 13.0 "    | 16 "      | 18.5 "    | 32 "                  | 26.5 "            |
| 25                       | 75 "              | 14.0 "    | 17.0 "    | 19.5 "    | 34.5 "                | 28.5 "            |
| 25                       | 80 "              | 14.5 "    | 17.5 "    | 20.5 "    | 36.5 "                | 30.5 "            |

The table needs a little explanation. The relative prices are based on a known per cent. of fat and price of cream. The first two columns give the per cent. of fat and price. In the succeeding columns are given the value of milk of different quality, also of butter-fat, and of butter based on the price and test of the cream. Thus, in the first line, cream testing twenty per cent. sells at 50 cents per gallon. When the producer can obtain this much for cream the milk, before skimming, should sell to the city dealer for twelve cents per gallon, if it tests 3 1-2 per cent. for 14 cents per gallon, if it tests 4 1-2 per cent., and for 17 cents, if it tests 5 1-2 per cent. The creamery should pay 28 cents for butter-fat, and the butter maker should realize 23 cents per pound for the butter. By looking over this table it is possible to tell, under ordinary conditions, which is the most profitable source to dispose of the milk. This table gives about the minimum and maximum prices paid in the State for milk and cream. They have been corrected for the estimated value of skim milk, and allowance has been made for freight. Skim milk has been calculated at 20 cents per 100 pounds, and the freight at two cents per gallon of milk and three cents per gallon of cream. The question of hauling is so difficult that it has not been considered in any connection. Each farmer can determine for himself about what it is worth, and make due allowance for the same in his calculations. As was stated be-

fore, there should be but little difference in the cost of hauling to a creamery and to a shipping point, while the value of the labor of butter making is certainly equal to that of hauling.

This table shows that in comparison to the shipping of milk practically all of the milk made into butter, or sold to a creamery, is done so at a loss. For instance, the table giving the prices paid for milk and cream shows that fifty cents per gallon for twenty per cent. cream, and ten cents per gallon for milk is the least paid by any of the city dealers. At ten cents a gallon value for milk creameries should pay 21 cents for butter fat. At 50 cents a gallon for cream the table shows that butter fat should bring about 28 cents, at the creamery, and at least 23 1-2 cents per pound should be realized for butter. This price for cream is the lowest summer price heard of any place in the State, and could doubtless be taken for the minimum. And the past summer has been one of rather low prices, too, as there was an enormous production of milk, owing to exceptionally good pastures.

But let us look at some of the winter prices. It is very easy to contract milk in the winter for 17 cents per gallon, and good dairy farmers could get 19 cents for milk testing 4 1-2 per cent. At the same time 70 cents could easily have been obtained for cream. At 70 cents for a twenty per cent. cream butter-fat should bring 40 cents at the creamery, and butter should sell at 33 cents to realize the same amount for the milk. Creameries never pay this amount for fat, and very little country butter ever brings 33 cents per pound.

The table of comparative prices will show why it is that so few creameries can afford to make butter. They cannot afford to pay prices for butter-fat that will compare favorably with the prices realized in shipping milk and cream. Were it possible to build up a fancy trade for an exceptionally good article, butter-making might compete with the city milk trade. But the best butter cannot be made without good milk, and the dairymen who produce the best milk can get a good price in the city, and realize the advantages of the city market. The creameries must take an inferior article which, because of its quality, cannot find a ready sale in the city markets. In truth, the greater part of the milk which finds its way to the local creameries is of doubtful quality. This is true in Baltimore and Harford counties, where there is such an abundance of good springs that the production of good milk should be easy and universal. In fact, about the only excuse for existence that the creamery nearby railroads can offer is that it can take a lot of milk which is too poor to find a regular city market, and by pasteurizing and the use of plenty of ice and preservatives get a cream that will supply a cheaper city trade, or that can be made into passable ice-cream. In localities somewhat remote from shipping points the creamery acts as a gathering point for the product of the neighborhood. But even then it is questionable if a system of farm separators and good management of the cream, which could be gathered up every day in covered wagons, could not be made more profitable to the farmers. As far as butter-making on the farm is concerned, its day in regions within the shipping zone of large cities is passed, except as it may be necessary to take care of an unwarranted summer surplus.

## DAIRYING UNDER SPECIAL AND LOCAL CONDITIONS.

A few special lines of dairy work are worthy of note in connection with this bulletin. Peculiar conditions are prevalent at Frederick, where, owing to strenuous competition, milk retails at four cents per quart. South of Frederick is one of the best practical dairy farms in the State, that supplies a large part of this trade, and seems to make a profitable business of it. Considering the fact that this dairyman furnishes as good milk as is sold in Baltimore, and is able to produce it and sell it at the price which is under the margin between purchase price and selling price that Baltimore dealers allow themselves for simply bottling and delivering the milk, it has attracted some attention and interest. The better Baltimore dairies sell milk at nine cents per quart, and it does not cost on an average of more than four cents per quart. This allows a margin of five cents per quart for handling and delivering. The Frederick dairy does it all for the original cost of the milk. Near Washington is a large section of very fine farming country that is engaged largely in the dairy industry. It has no railroad outlet, and is too far from the city for individual farmers to haul milk to the city. It has, however, very fine pikes leading to the city. The milk produced in the section is gathered up by three or four dairymen in the county, and skimmed and the cream hauled to the city. One of these dairymen supplies gravity raised cream to a special trade in the city for ice-cream, and receives about fifteen cents more per gallon for this than other cream is sold for. The fat test of this cream was not known, but is likely about twenty per cent.

Dairying on a large part of the Eastern Shore is entirely distinct in opportunities from that of other parts of the State, as there is no opportunity to furnish milk for a city supply; while the few small towns furnish a trade for a few interesting dairies, they have small influence on the large area of tillable land. A few years ago a dairy supply company entered the territory, and induced the farmers to build a number of creameries. But they were so poorly patronized and managed that they practically failed. A few of them are doing a small business, but no section or farm is entirely devoted to producing milk. The milk is poor, and but a very small price is paid—fifty cents per hundred being the ruling price. The Eastern Shore has many of the characteristics of some of the well-known Western States, and it would appear as though there should be a chance for profitable dairying, but the attempt to develop it was very discouraging.

There has never been any particular effort to develop a well-paying trade in butter and milk, aside from the Walker Gordon milk, as has been done in some of the Northeastern cities. A few institutions, such as Johns Hopkins Hospital, in Baltimore, pay well for a good article. One would think that the class of people spending the winter in Washington would demand and pay for an exceptionally good article, but men who have tried to start such a trade say that it has failed.

# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 98.

NOVEMBER, 1904.

## DAIRY FEEDING EXPERIMENTS.

### Home-Grown Protein as a Substitute for Purchased Feeds and Tests of Soiling Crops.

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By C. F. Doane.

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According to the last census Maryland has about 150,000 dairy cows. It is very likely that every year at least \$2,250,000 is expended by the dairymen of the State for so-called concentrate protein feeds, such as wheat bran, cottonseed meal, gluten meal, linseed meal, malt sprouts, brewers' grains, and a few others. This allows \$15.00 per cow per year, which is a very moderate estimate of what the cow should have. It is very doubtful if the dairy cows average more than \$15.00 profit annually with the feeds given at the present time. Calculating upon this basis about half of the possible profits of the dairy goes into the pockets of the feed dealers.

The question of how to get away from this heavy expenditure is one of great importance for the consideration of dairymen. At the present time, and with the crops usually raised, the purchasing of protein feeds is absolutely essential to profitable dairying. Though it may take a large share of the probable returns for the purchasing of feed, yet, if it were not possible to secure these feeds the profits now derived by the dairymen would be lessened, and even cause the business to be conducted at an actual loss. Protein feed is absolutely necessary to successful dairying. This feed must either be bought or raised, and until a very short while ago the idea of raising all of the protein feed necessary for a herd of cows appeared to be highly preposterous; and even yet it seems almost impossible to most dairymen. The desirability of raising a part, or all, of the protein feed necessary for the dairy herd will be apparent to every man concerned in the dairy business.

The principal protein-bearing foods which are raised in different sections of the country are clover, cowpeas, soja beans and alfalfa, each one being supposedly better suited to a particular locality, though this is only partly true. On almost every farm in Maryland two or more of these leguminous plants can be raised, and by a proper combination of them with the grains usually grown, it is not only possible, but practical, to produce a good and well-balanced ration for dairy

cattle. In fact, either alfalfa or cowpea hay, combined with corn chop, will make a ration sufficiently near balanced for all practical purposes.\*

This would make it possible for all of the feed necessary for the dairy herd to be raised on the farm, and would cut down the feed bills to a minimum, providing, of course, that these feeds can be raised in sufficient quantity. Cowpeas have been raised so extensively in Maryland that there is no doubt but what practically every section will produce paying crops, and most all farmers know how to grow and handle them. Alfalfa is a newer and less well known plant than cowpeas in this State. Where it can be successfully raised, it is more valuable than cowpeas, as it is of higher quality, and yields much more.

### GROWING ALFALFA.

Alfalfa should yield practically four tons of hay per acre on land of average fertility. Bulletin No. 85, of this Station, which can be had upon application, treats very thoroughly of the culture and growing of this valuable and interesting plant. But since the publication of this Bulletin a most valuable fact in connection with the growing of alfalfa has been discovered by the Illinois Experiment Station. It has been found that the land must be inoculated with the bacteria, which assists the alfalfa plant in drawing its supply of nitrogen from the air, as do red clover and cowpeas. In the light of this discovery, the repeated failures to grow this plant in the Eastern States is at once apparent. In the comparatively few cases where alfalfa has been grown in Maryland, without difficulty in getting it started, it has been found that the soil was naturally inoculated, which is evidently not true of the greater part of the State. To secure the inoculation artificial means must be resorted to at most places. Two ways are open to do this. One is to sow the alfalfa, and allow it to stand for a year. The greater part of the plants will die, but a few will be found to be growing vigorously, these being inoculated in some unexplainable way. If at the end of the year this same piece of land is ploughed up, and again seeded to alfalfa, there is a good chance that it will grow very successfully, the few plants which grew with the first seeding having furnished the inoculation for the entire piece. Another way is to inoculate the land with soil from a field which is growing alfalfa † successfully. For this purpose the soil should be taken from the surface, and not deeper than eight inches. This should be spread over the land to be inoculated and incorporated by means of a harrow. The soil for inoculation should not be allowed to dry out. It is claimed by different authorities to take from five hundred to two thousand pounds of soil per acre for

This is true of cowpea hay. There seems, however, to be an unexplainable discrepancy in the value of cowpea hay and cowpea silage for food. As given in available tables, cowpea hay contains digestible protein and carbohydrates in about the proportion of one to four, while the silage has these constituents in the proportion of one to six. This is too great a variation to be accepted without question. Judging from different data, it is very likely that the silage has at least two per cent. of digestible protein.

†Soil on which Bokhara Clover (*Melilotus albi*), also sometimes called "Sweet Scented" Clover, and "Bee" Clover grows, has recently been found to be just as effective for inoculation purposes as alfalfa soil. The Bokhara Clover grows wild in most parts of Maryland.

inoculation. When it is considered that a good piece of alfalfa will produce at least four tons of hay per acre, and that the feeding quality is superior to any other that can be grown, the extra work required in getting it established will not appear so great or useless.

### FEEDING EXPERIMENT No. 1.

#### COMPARISON OF A RATION OF ALFALFA AND CORN MEAL WITH ONE OF CORN SILAGE AND MIXED GRAINS.

The object of this experiment was to test a balanced ration which could be entirely produced on the farm with one which is used extensively in Maryland, and which requires the purchasing of considerable of the rich protein feeds.

Good corn silage, with the right proportion of concentrate protein feeds, will perhaps produce more milk than any other feed used extensively in the Eastern States at the present time. In taking up this experiment two points were taken for granted. First, if as much milk could be produced with alfalfa as with silage, when practically the same amount of grain was fed, in both cases, the value of alfalfa as a dairy feed would be established. Second, if the grain fed could be made up entirely of staple products grown on Maryland farms, the great value as a money saver would be established. We think that the results will show that these points were thoroughly established.

The plan of the experiment was to divide the cows into two lots as nearly equal in every respect as possible. During the first period of twenty-eight days Lot No. 1 received silage with concentrate protein feeds to balance, while Lot No. 2 received alfalfa hay with corn meal to balance during the same time. The next month the feed of the two lots were reversed, No. 1 receiving the alfalfa hay and ration, while Lot No. 2 received corn silage ration. The detail of the feeding and the quantity consumed, with other notes made, were as follows: The rations for the cows in this experiment were balanced on the basis of the average amount of hay and silage fed to the herd. Then all of the hay or silage that each individual would eat was given, while the same amount of grain was fed to each cow. This may be open to criticism, but with our conditions it appeared to be the best solution of a somewhat difficult problem. As both lots were about the same in every way this possible irregularity in the plan of feeding will not destroy the comparative results. The ration was balanced to about 1:5.5, and the following grain ration was fed with the silage:

|                    |           |
|--------------------|-----------|
| Malt sprouts ..... | 3 pounds. |
| Linseed Meal ..... | 1 pound.  |
| Gluten Meal .....  | 1 pound.  |
| Corn Chop .....    | 1 pound.  |

This may not appear as a very heavy grain ration, but it must be remembered that well-eared corn silage carries fully five pounds of grain in forty pounds; one day's feed of silage, which would bring

the grain ration to a total of eleven pounds, a comparatively large feed allowance.

The alfalfa ration was balanced to 1:5.3, which was a little narrower than the silage ration. Seven pounds of corn meal was fed per day, though it was desired to feed the same amount of grain both with the silage and alfalfa. With the alfalfa, however, six pounds of grain would have made a much too narrow ration, and though the alfalfa ration as fed was narrower than the other, it was allowed to go in this way because the silage was as narrow as should be fed, owing to the expenditure for protein feeds. We are pretty well satisfied at the Station that we fed more grain with the alfalfa than was needed for the best results, as the cows while receiving this ration all gained in weight, materially more than while receiving the silage ration.

The following table will show the amounts of feed eaten by the cows under experiment:

TABLE No. 1.

| Lot 1.  |                         |                           |                         |                          |
|---------|-------------------------|---------------------------|-------------------------|--------------------------|
| Cow No. | First Period.           |                           | Second Period.          |                          |
|         | Grain Eaten.<br>Pounds. | Alfalfa Eaten.<br>Pounds. | Grain Eaten.<br>Pounds. | Silage Eaten.<br>Pounds. |
| 58      | 196                     | 564                       | 168                     | 1440                     |
| 39      | 196                     | 564                       | 168                     | 1300                     |
| 37      | 196                     | 543                       | 168                     | 1175                     |
| 71      | 196                     | 493                       | 168                     | 1160                     |
| 64      | 196                     | 339                       | 168                     | 895                      |
| 56      | 196                     | 320                       | 168                     | 860                      |
| 66      | 196                     | 350                       | 168                     | 875                      |
| 61      | 196                     | 408                       | 168                     | 950                      |

| Lot 2.  |                         |                          |                         |                           |
|---------|-------------------------|--------------------------|-------------------------|---------------------------|
| Cow No. | First Period.           |                          | Second Period.          |                           |
|         | Grain Eaten.<br>Pounds. | Silage Eaten.<br>Pounds. | Grain Eaten.<br>Pounds. | Alfalfa Eaten.<br>Pounds. |
| 23      | 168                     | 1180                     | 196                     | 470                       |
| 50      | 168                     | 889                      | 196                     | 372                       |
| 53      | 168                     | 1056                     | 196                     | 374                       |
| 35      | 168                     | 1440                     | 196                     | 544                       |
| 54      | 168                     | 1072                     | 196                     | 378                       |
| 72      | 168                     | 1580                     | 196                     | 552                       |
| 55      | 168                     | 1038                     | 196                     | 369                       |

It will be noticed that there was a great variation in the amounts of hay and silage eaten by the different cows. It will be noticed that cows Nos. 58 and 39 consumed a little more than twenty pounds of hay each and for a time No. 58 received daily twenty-two pounds of hay, and as she was eating it up clean at every feed it was quite evi-

dent that the limit had not been reached. After the ration had been thoroughly adjusted there were a number of cows that would eat more than eighteen pounds per day of the hay. These same cows would eat from forty to fifty pounds per day of silage, with an average of forty-five pounds. It is interesting to compare total amounts of digestible material in the two feeds. In the alfalfa there was a total of 9.62 pounds of digestive nutrients, and in the silage 6.32 pounds. The fat was multiplied in each case by the factor to give it the value of carbohydrates. The alfalfa ration had 16.5 pounds of dry matter, while the silage had 9.4 pounds. This is a very convincing illustration of the fact that the same cow does not require the same amount of dry matter in rations of different feeds.

The comparative results in milk yields are given in the following tables:

TABLE 2.

## Lot 1.

| Cow No.                     | First Period.                      | Second Period.                    |
|-----------------------------|------------------------------------|-----------------------------------|
|                             | Alfalfa.<br>Milk Produced, Pounds. | Silage.<br>Milk Produced, Pounds. |
| 58                          | 669.3                              | 665.6                             |
| 39                          | 556.3                              | 461.2                             |
| 61                          | 534.1                              | 500.8                             |
| 37                          | 570.7                              | 513.7                             |
| 56                          | 276.8                              | 263.3                             |
| 66                          | 400.5                              | 377.9                             |
| 71                          | 333.2                              | 311.5                             |
| 64                          | 336.1                              | 385.6                             |
| Total.....                  | 3677.0                             | 3479.6                            |
| Loss in Second Period ..... |                                    | 197.4                             |

## Lot 2.

| Cow No.  | First Period.                     | Second Period.                     |
|--|-----------------------------------|------------------------------------|
|  | Silage.<br>Milk Produced, Pounds. | Alfalfa.<br>Milk Produced, Pounds. |
| 55   | 319.6                             | 354.1                              |
| 50   | 329.3                             | 357.4                              |
| 72   | 569.8                             | 561.8                              |
| 35   | 611.1                             | 655.8                              |
| 23   | 586.8                             | 559.0                              |
| 53   | 461.7                             | 814.1                              |
| 54   | 594.2                             | 602.1                              |
| Total.....                                       | 3492.5                            | 3571.3                             |
| Gain, Second Period .....                        |                                   | 78.8                               |
| Total milk produced by both lots on Alfalfa..... |                                   | 7248.3                             |
| Total milk produced by both lots on Silage.....  |                                   | 6972.1                             |
| Amount gained by Alfalfa over Silage.....        |                                   | 276.2                              |

Some interesting facts can be seen in the foregoing tables. The first is that the alfalfa showed itself superior to the silage as a food for dairy cows by a safe margin in the total milk produced. Another is, that out of the eight cows in Lot No. 1 seven went down in their milk yield, and one, No. 64, increased. Out of Lot No. 2 four increased in their milk yield in the second period, while receiving alfalfa hay, one remained practically stationary, and two decreased in their yield. No. 23, the only one that showed any material decrease, was sick and off feed for a part of her second period, which would likely account for her smaller yield. These results are certainly positive, and would represent about what might be expected under any ordinary dairy conditions. They not only show that where alfalfa can be raised it is possible and practical to produce a good ration for the dairy herd, but shows further that this ration is even better than any that can be purchased.

### EXPERIMENT No. 2.

#### ALFALFA AND SILAGE WITHOUT GRAIN.

Following the experiments comparing the feeding value of corn silage and alfalfa, a test was made to determine if it were practical to feed dairy cows giving a good flow of milk on alfalfa and silage without grain, other than that contained in the corn silage. As our supply of alfalfa hay was becoming short it was not possible to conduct this work with the entire herd, so three cows were selected to make the test, which, in view of the results obtained, proved to be a sufficient number. The general plan was to give the cows cut alfalfa and silage mixed, in about the proportion to give the equivalent of one feed per day of alfalfa and one feed of silage. This required ten pounds of alfalfa to twenty pounds of silage.

In table three are given the milk yield of these cows for a period of fifteen days during the test, together with the yields for a like period immediately following, when the cows received the usual ration of corn silage and mixed grains.

TABLE No. 3.

#### MILK YIELD IN FIFTEEN DAYS.

| Cow No.                     | 37          | 58          | 23          |
|-----------------------------|-------------|-------------|-------------|
| Fed Alfalfa and Silage..... | 261 pounds. | 306 pounds. | 269 pounds. |
| Fed Silage and Grain.....   | 271 pounds. | 338 pounds. | 297 pounds. |

It will be noticed from the table that all of the cows gave materially less milk while receiving the alfalfa and silage ration than in the same length of time while receiving silage and grain. These cows, previous to the test, had also been receiving silage and grain, and the immediate drop in their daily milk yield, when changed to the alfalfa

and silage mixture, was sharp and rather startling. As no individual of the rest of the herd, which was continued on the silage and grain, showed any material variation, it seemed conclusive that the alfalfa and silage did not furnish all that was required for a maximum yield, and that some concentrated food was necessary. This was certainly not due to the cows not eating a sufficient quantity, for Nos. 23 and 37 ate forty pounds daily, and No. 58 ate fifty pounds daily.

The results obtained from the alfalfa and silage mixture are interesting, from the fact that, theoretically, they should have furnished an almost perfectly balanced ration; and both feeds are very palatable to animals, and the mixture was eaten greedily. In the proportions used, it gave a nutritive ratio of 1:5.5, which is very satisfactory, and, furthermore, it gave practically the same quantity of digestible nutrients, as did the silage and grain ration used. The two cows eating forty pounds of the mixture received 10.87 pounds of digestible nutrients, while the same cows, when eating forty-five pounds of silage received 10.84 pounds of digestible nutrients. Considering these facts, one would certainly expect approximately the same results in milk yield from both feeds. The fact that this was not the case would tend to show that the digestible portions of different feeds cannot be depended upon to produce the same results, even though it is commonly considered that a pound of digestible protein has equal value, no matter what its source.

At least these results would seem to show that the protein from alfalfa hay could not be utilized to the same extent in making milk as that from grain, and would indicate that there should be a different economic value attached to digestible protein from roughage and from concentrated feeds.

The results would indicate that the alfalfa (hay) meal, which has recently been placed on the market, as a substitute for wheat bran, might not have the same feeding value as the bran, even though it has practically the same chemical composition.

### EXPERIMENT No. 3.

#### COWPEA HAY AND COWPEA SILAGE AS A FEED FOR COWS.

The cowpea has become the leading leguminous crop of the Southern States, and it will doubtless become more popular, and highly appreciated when its full value becomes better known. It is not only valuable as a forage crop, but it also ranks high as a soil improver, and will be largely used for this purpose when the Southern farmer realizes the necessity of leguminous plants in their farm economy, and adopts rotations for availing of these crops.

Cowpeas have been grown at this Station for a number of years, and used chiefly as a green manure; but during the last few years it has been deemed more profitable to utilize them in some way as feed

for stock. For this purpose the cowpeas have been made into hay and silage.

### HOW THE COW PEA CROP WAS HANDLED.

In growing cowpeas for hay or silage it has been the custom to seed them with an ordinary grain drill, at the rate of four to five pecks per acre, setting the drill on the oats scale.

Cowpeas may be seeded any time from the 20th of May to the first of July, but the results here have usually favored seeding from the 10th to the 15th of June. A number of varieties have been tested for hay and silage purposes, but so far the most satisfactory results have been obtained with the variety known as "Wonderful" or "Unknown."

### MAKING HAY.

For making hay the cowpeas were cut with a mowing machine, and allowed to thoroughly wilt. They were then raked into windrows, and placed in small cocks. The hay remained in these cocks until thoroughly cured. The cocks were turned over a couple of hours, before hauling in, so as to dry the bottoms. Hay made in this manner should retain the leaves, and be of a nice green color. In making hay of the Black, Whip-poor-will, Clay and varieties that will produce considerable seed, in this section, a good time to cut them is when the first pods begin to turn yellow. The "Wonderful" variety will not mature seed in this latitude, and it will often have to be cut before any pods are formed, and to this extent is not of as good quality as some other varieties, but it will produce more hay. Cowpeas should give from one and one-half to two and one-half tons of hay per acre.

### MAKING SILAGE.

In making silage the peas should be cut at the same stage as for hay. They are cut with a mowing machine, and are raked up with the horse rake, and hauled in at once and put in the silo. Peas may be put in the silo without cutting, but of course will take up less space and pack closer if run through a cutter. Cowpeas may be put into the silo with corn. For this purpose it is well to run them through the cutter, so that they will be mixed about one-third peas and two-thirds corn. Cowpeas should yield from six to ten tons of silage per acre.

### FEEDING EXPERIMENT WITH COWPEAS.

The feeding experiments with cowpeas were conducted through two winters. The cow peas used in this test were of the "Black" variety, and they were allowed, unavoidably, to become too mature to make either the best of hay or silage. In making the silage, owing to rain and a break in the cutter, the peas stood several days after cutting before they were placed in the silo. This also detracted from the quality of the silage. Cowpea silage is quite different in general appear-

ance from corn silage. It becomes darker in color, and does not have quite as pleasant an odor. By tests in the laboratory it was found to be less acid than corn silage. When the cows were first given the cowpea silage they did not seem to relish it, and some individuals refused to eat it entirely. The apparent dislike at first was only another instance of many similar ones, when new food is offered, and serves as additional proof that animals, as well as men, must be given time to acquire a taste for many foods. The cows soon learned to like the cowpea silage, though, as will be seen from the tables showing the amount consumed, never ate as much as of the corn silage; but judging from the milk yields they evidently consumed sufficient (see table 9) to do good work. In this connection it may be noted that none of the cows in the Station herd consume as much roughage as is commonly mentioned by many writers and recorded by some experimenters. The tests conducted consisted in a comparison of the following rough feeds:

- 1.—Cowpea hay.
- 2.—Cowpea silage.
- 3.—Cowpea silage and corn silage fed in equal parts by weight.
- 4.—Corn silage.

These rations of the above-named rough feeds were balanced so that they approximated a ratio of 1 to 5.5 by means of hominy chop, wheat bran and gluten meal used in varying proportions. Each cow received all she would eat of the rough feeds, and a liberal allowance of grain. All the cows used in the test had been receiving the same ration previous to the experiment, which consisted of corn silage and mixed grains. Before entering on the regular test, the cows were changed gradually to the feeds used in the test, and given a preliminary period. The following tables give the amounts of food consumed by the different lots of cows:

TABLE No. 4.

Lot No. 1—Fed on Cowpea Hay Ration.

| Cow Number.* | Total hay<br>Eaten 30 days. | Total grain<br>Eaten 30 days. | Average hay<br>Eaten daily. | Average grain<br>Eaten daily. |
|--------------|-----------------------------|-------------------------------|-----------------------------|-------------------------------|
| 1            | 510                         | 240                           | 17                          | 8                             |
| 7            | 510                         | 240                           | 17                          | 8                             |
| 12           | 420                         | 240                           | 14                          | 8                             |
| 13           | 420                         | 240                           | 14                          | 8                             |
| 29           | 510                         | 240                           | 17                          | 8                             |
| 36           | 360                         | 240                           | 12                          | 8                             |
| 39           | 510                         | 240                           | 17                          | 8                             |

TABLE No. 5.

Lot No. 2.—Fed on Cowpea Silage Ration.

| Cow Number. | Total silage<br>Eaten 30 days. | Total grain<br>Eaten 30 days. | Aver. daily<br>Silage ration. | Aver. daily<br>grain ration. |
|-------------|--------------------------------|-------------------------------|-------------------------------|------------------------------|
| 15          | 900                            | 240                           | 30                            | 8                            |
| 23          | 900                            | 240                           | 30                            | 8                            |
| 33          | 900                            | 240                           | 30                            | 8                            |
| 21          | 900                            | 240                           | 30                            | 8                            |
| 37          | 900                            | 240                           | 30                            | 8                            |
| 47          | 900                            | 240                           | 30                            | 8                            |
| 17          | 900                            | 240                           | 30                            | 8                            |

TABLE No. 6.

Lot No. 3.—Fed on Corn and Cowpea Silage Ration.

| Cow Number. | Total silage<br>Eaten 30 days. | Total grain<br>Eaten 30 days. | Aver. silage<br>Eaten daily. | Aver. grain<br>Eaten daily. |
|-------------|--------------------------------|-------------------------------|------------------------------|-----------------------------|
| 27          | 1080                           | 240                           | 36                           | 8                           |
| 31          | 1080                           | 240                           | 36                           | 8                           |
| 35          | 1080                           | 240                           | 36                           | 8                           |
| 41          | 1080                           | 240                           | 36                           | 8                           |
| 49          | 1080                           | 240                           | 36                           | 8                           |
| 59          | 1080                           | 240                           | 36                           | 8                           |

TABLE No. 7.

Lot No. 4.—Fed on Corn Silage.

| Cow Number. | Total silage<br>Eaten 30 days. | Total grain<br>Eaten 30 days. | Aver. silage<br>Eaten daily. | Aver. grain<br>Eaten daily. |
|-------------|--------------------------------|-------------------------------|------------------------------|-----------------------------|
| 25          | 1200                           | 240                           | 40                           | 8                           |
| 26          | 1200                           | 240                           | 40                           | 8                           |
| 28          | 1200                           | 240                           | 40                           | 8                           |
| 30          | 900                            | 240                           | 30                           | 8                           |
| 38          | 900                            | 240                           | 30                           | 5                           |
| 42          | 1200                           | 240                           | 40                           | 8                           |

The average daily yield of each cow for eight days prior to beginning the experiment was taken as a basis for determining the comparative value of the different rations fed. The test lasted for twenty-three days and the total milk yield and the average daily milk yield covers this period. The tables giving the feed eaten cover a period of thirty days. As no attempt will be made to compute the cost of milk and butter fat, the variations in periods of time covered need not lead to any misunderstanding. The cows were divided into lots according to the amount of milk they were giving, and the rate at which the indi-

viduals were falling off in their yield. The following tables give the amounts of milk produced during the test, and the eight days previous with the daily average for the two periods.

TABLE No. 8.

Lot No. 1.—Milk Produced by Cows Receiving Cowpea Hay.

| Cow Number.                  | 8 days before<br>test, milk lbs. | 23 days of<br>test, milk lbs. | Daily aver.<br>before test,<br>milk pounds. | Daily aver.<br>during test<br>milk pounds. |
|------------------------------|----------------------------------|-------------------------------|---|--|
| 1                            | 182.6                            | 500.7                         | 22.8  | 21.7                                       |
| 13                           | 178.3                            | 386.8                         | 22.3  | 16.8                                       |
| 29                           | 136.7                            | 391.6                         | 17.1  | 17.0                                       |
| 7                            | 124.5                            | 339.3                         | 15.6  | 14.7                                       |
| 36                           | 90.7                             | 255.0                         | 11.3  | 11.1                                       |
| 39                           | 66.6                             | 213.2                         | 8.3   | 9.3  |
| 12                           | 103.6                            | 268.1                         | 12.9  | 11.7                                       |
| Average per cow per day..... |                                  |                               | 15.7  | 14.6                                       |

TABLE No. 9.

Lot No. 2.—Milk Produced by Cows Receiving Cowpea Silage.

| Cow Number.                  | 8 days before<br>test—milk lbs. | 23 days of<br>test milk pounds. | Daily aver.<br>before test,<br>milk lbs. | Daily aver.<br>during test,<br>milk lbs. |
|------------------------------|---------------------------------|---------------------------------|--|--|
| 15                           | 152.0                           | 483.1                           | 19.0                                     | 21.0                                     |
| 23                           | 131.9                           | 385.4                           | 16.5                                     | 16.7                                     |
| 33                           | 131.9                           | 409.7                           | 16.5                                     | 17.8                                     |
| 21                           | 77.9                            | 284.2                           | 9.7                                      | 12.3                                     |
| 37                           | 101.4                           | 344.3                           | 12.4                                     | 15.0                                     |
| 47                           | 108.1                           | 339.1                           | 13.5                                     | 14.8                                     |
| 17                           | 71.1                            | 245.3                           | 8.9                                      | 10.7                                     |
| Average per cow per day..... |                                 |                                 | 13.6.....                                | 15.5                                     |

TABLE No. 10.

Lot No. 3.—Milk Produced by Cows Receiving Corn and Cowpea Silage.

| Cow Number.                  | 8 days before<br>test, milk lbs. | 23 days of<br>test, milk lbs. | Daily aver.<br>before test,<br>milk lbs. | Daily aver.<br>during test<br>milk lbs. |
|------------------------------|----------------------------------|-------------------------------|--|---|
| 31                           | 186.1                            | 543.3                         | 23.3                                     | 23.6                                    |
| 27                           | 130.2                            | 411.7                         | 15.0                                     | 17.9                                    |
| 59                           | 168.9                            | 514.5                         | 21.1                                     | 22.3                                    |
| 35                           | 165.1                            | 465.6                         | 20.6                                     | 20.2                                    |
| 41                           | 110.4                            | 385.6                         | 13.8                                     | 16.8                                    |
| 49                           | 41.4                             | 212.3                         | 5.1                                      | 9.2                                     |
| Average per cow per day..... |                                  |                               | 16.6                                     | 18.3                                    |

TABLE No. 11.

Lot No. 4.—Milk Produced by Cows Receiving Corn Silage.

| Cow Number.                  | 8 days before test—milk lbs. | 23 days of test milk lbs. | Daily aver. before test, milk lbs. | Daily aver. during test, milk lbs. |
|------------------------------|------------------------------|---------------------------|------------------------------------|------------------------------------|
| 28                           | 195.6                        | 545.0                     | 24.4                               | 23.7                               |
| 26                           | 182.4                        | 497.8                     | 22.8                               | 21.6                               |
| 58                           | 192.9                        | 548.5                     | 24.1                               | 23.8                               |
| 30                           | 92.5                         | 336.4                     | 11.6                               | 14.6                               |
| 25                           | 108.7                        | 329.0                     | 13.6                               | 14.3                               |
| 38                           | 37.2                         | 127.9                     | 4.6                                | 5.6                                |
| 42                           | 95.5                         | 322.8                     | 11.9                               | 14.0                               |
| Average per cow per day..... |                              |                           | 16.1                               | 16.8                               |

TABLE No. 12.

Average Daily Milk Yields by Cows on Different Rations.

|                       | Aver. daily product—milk lbs. in 8 days before test. | Aver. daily product—milk lbs. during test. | Aver. daily gain or loss. |
|-----------------------|--|--|---------------------------|
| Cows receiving        |  |  |                           |
| Cowpea hay . . . . .  | 15.7   | 14.6                                       | —1.1                      |
| Cows receiving Corn   |  |  |                           |
| and Cowpea Silage.    | 16.6   | 18.3                                       | +1.7                      |
| Corn Silage . . . . . | 16.1   | 16.8                                       | + .7                      |
| Cowpea Silage . . . . | 13.6   | 15.5                                       | +1.9                      |
| Cows receiving        |  |  |                           |
| Cows receiving        |  |  |                           |

The results given in the foregoing tables speak for themselves. They are made plainer in Table No 12, which gives a summary of the averages. This table shows that the cows receiving cowpea silage made the best gains, and those receiving the corn and cowpea silage mixed a close second. The cows receiving corn silage seemed to do a little better than they had done during the eight preliminary days of the test, which might be taken as indicating that there was a general tendency on the part of the herd to increase its milk yield. The results cannot be taken, however, other than that the cowpea silage is a little better for milk production than corn silage. The results in the case of the silage are made more emphatic by the fact that in only one instance did a cow give an average daily yield less than when receiving corn silage in the preliminary eight days, and the falling off in yield was very small, while with the corn silage three of the cows fell off in their average daily yield.

The cowpea hay gave decidedly unsatisfactory results. Table No. 8 shows that all but one of the cows fell off during the test, and

Table No. 12 shows that the average daily loss was over one pound. Compared with the results obtained from the other feeds this was quite noticeable. However, the trials with cowpea hay were rather unsatisfactory, everything considered. Table No. 4 shows that the amount of this hay eaten by the different cows varied materially. Some ate on an average of seventeen pounds per day, while in one instance the cow would not eat more than eight pounds per day, for a short period, and averaged only twelve pounds per day for the entire period. Strange to say, however, this particular animal did not fall off materially in her milk yield, which was no doubt due to the fact that she was receiving a comparatively large grain ration for the amount of milk she was giving. However, No. 13 refused to eat a large quantity of cowpea hay, and it showed in her falling off over five pounds per day in her average milk yield. The cowpea hay used in these trials was too old for the best feed, and was slightly woody. Had a good quality of hay been at hand, better results could have been expected. The results are given for what they may be worth. The test was not as fair as could have been desired.

#### EXPERIMENT No. 4.

#### COMPARISON OF COWPEA SILAGE WITH CORN SILAGE.

As has been noted, experiments comparing the feeding value of corn silage and cowpea silage were again undertaken in the winter of 1903-1904. At this time much better cowpea silage was on hand than was the case in the previous experiments. In fact, from our knowledge of this product, it might have been considered nearly perfect silage.

The cowpea silage was made from the variety called "Unknown" or "Wonderful." These produce a few pods and no mature peas, but the yield per acre was greater than from the variety used in the previous experiment. All cows in the herd seemed to relish it very much from the start, and as can be seen from the tables ate a much larger quantity per cow per day than in the former experiments. This was partially due to the fact that this silage carried more moisture. The plan of these second experiments was different from that of the first year, being much the same as with the experiments No. 1, page 59, with alfalfa hay. The herd was divided into two lots. One lot received corn silage for three weeks, and the other lot cowpea silage during the same time. Then the feed was changed, and the first lot received cowpea silage for three weeks and the other lot corn silage.

This gives a somewhat fairer and more convincing comparison. In this experiment six pounds of grain per day was the limit for any cow, and a few received less than this quantity. Corn silage carries more grain than cowpea silage, but a practical test of value to dairy-men required that the same amount of grain be fed to both lots. The ration was balanced approximately to a nutritive ratio of 1 to 5.5. This required very little grain other than corn chop.

The following table shows the amount of food consumed by the two lots of cows:

TABLE No. 13.

Showing the Amount of Food Consumed by the Cows During the Cowpea Silage and Corn Silage Periods. (Length of Periods, 21 Days).

## Lot No. 1.

| Cow Number. | First Period.  |        | Second Period. |        |
|-------------|----------------|--------|----------------|--------|
|             | Cowpea Silage. | Grain. | Corn Silage.   | Grain. |
| 49          | 1055           | 126    | 875            | 126    |
| 35          | 1175           | 126    | 970            | 126    |
| 54          | 1070           | 126    | 840            | 126    |
| 55          | 980            | 84     | 840            | 84     |
| 23          | 1175           | 126    | 910            | 126    |
| 53          | 980            | 84     | 875            | 126    |
| Total.....  | 6435           | 672    | 5245           | 672    |
| Average.... | 1073           | 112    | 874            | 112    |

## Lot No. 2.

| Cow No.     | First Period. |        | Second Period. |        |
|-------------|---------------|--------|----------------|--------|
|             | Corn Silage.  | Grain. | Cowpea Silage. | Grain. |
| 37          | 1140          | 126    | 1140           | 126    |
| 71          | 1130          | 105    | 1140           | 126    |
| 64          | 920           | 84     | 840            | 84     |
| 61          | 1000          | 105    | 875            | 105    |
| 39          | 1140          | 126    | 1080           | 126    |
| 58          | 1680          | 126    | 1200           | 126    |
| 73          | 1110          | 126    | 1150           | 126    |
| Total.....  | 8120          | 798    | 7425           | 945    |
| Average.... | 1160          | 114    | 1061           | 135    |

The milk yields during these two periods from each lot of cows are given in Table No. 14.

TABLE No. 14.

Milk Produced in Three Weeks.

Lot No. 1.

| Cow No.     | First Period.<br>Cowpea Silage.<br>milk pounds. | Second Period.<br>Corn Silage.<br>milk pounds. |
|-------------|---|--|
| 23          | 412.8   | 385.1  |
| 35          | 414.4   | 446.9  |
| 54          | 387.7   | 356.0  |
| 49          | 506.0   | 487.5  |
| 53          | 303.6   | 300.9  |
| 55          | 239.5   | 249.4  |
|             | <hr/>   | <hr/>  |
| Total. .... | 2264.0  | 2225.8   |
|             | Loss when fed, corn silage                      | 38.2   |

Lot No. 2.

| Cow Number. | Corn Silage.<br>milk lbs. | Cowpea Silage.<br>milk pounds. |
|-------------|---------------------------|--------------------------------|
| 58          | 449.9                     | 468.5                          |
| 39          | 252.1                     | 266.4                          |
| 37          | 366.4                     | 345.2                          |
| 61          | 326.0                     | 343.1                          |
| 73          | 346.6                     | 380.4                          |
| 71          | 225.6                     | 245.3                          |
| 64          | 261.6                     | 270.1                          |
|             | <hr/>                     | <hr/>                          |
| Total. .... | 2228.2                    | 2319.0                         |
|             | Gain on Cowpea Silage     | 90.8                           |

Total milk given by both lots on Corn Silage.....4454.0 pounds.  
 Total milk given by both lots on Cowpea Silage.....4583.0 pounds.

Total gain of Cowpea Silage ..... 129.0

The table shows that out of the six cows receiving cowpea silage the first period four fell off in their yield, and two gained in the second period. In the lot receiving corn silage the first period six cows out of seven in the lot gained in their milk yield in the second period.

This would appear to be satisfactory proof that the cowpea silage was a slightly better food than corn silage. As the same results were obtained in the former experiments it emphasizes the value of cowpea silage for dairy cows.

Mention was made in the discussion of the alfalfa experiments of the desirability for the farmer raising his own protein, and in this way becoming independent of the feed dealer. It has been shown that this is entirely possible with alfalfa, and very nearly, if not entirely, so with cowpeas.

It is true, however, that practically as much grain was needed with cowpea silage as with corn silage, and though this grain is or can be raised on the farm, and the grain to feed with corn silage needs be purchased, one is about as valuable on the market as the other. This is compensated for in another way. The dealer in fertilizers gets about as much of the average farmer's money as does the feed dealer. To reduce the fertilizer bill as much as possible, consistent with good crops, should be the aim of every farmer. Both alfalfa and cowpea belong to the class of plants that obtain a great part of their nitrogen from the air, and in doing this they enrich the soil materially, instead of exhausting it, as will many of the forage crops commonly grown, except, of course, clover. Cowpeas are perhaps the most valuable fertility restorer available for the Southern farmer, as it will grow on soil where no other forage plant will grow. Alfalfa, under certain conditions, is also very valuable, and in growing either of these crops for feeding dairy or other stock, the farmer is not only growing his own protein feed, but he is adding nitrogen to the soil.

#### • EXPERIMENT No. 5.

#### COMPARISON OF RYE SOILING WITH SILAGE.

Among dairymen who soil instead of pasturing their herd rye is perhaps the best known and most popular of the early crops grown for this purpose. It owes its popularity partially to the fact that it is large enough for feed earlier in the spring than any other crop which farmers have been able to grow on all classes of soils, and partially to a misconception of its actual value as a feed for dairy cows. There is a belief among dairymen, which might also be called a superstition, that any fresh green feed commonly given to stock is more valuable for milk production than any of the winter feeds. This belief is undoubtedly a relic of the time when cows received a decidedly unbalanced ration of dry feeds, and from this feed were turned in the spring on a good pasture, which is the best of all feeds, and a nearly balanced ration. The results were so pronounced that the conclusion was naturally drawn that any green forage crop was better than all dry feeds.

The result of this belief has been that the earliest possible green crop for spring feeding was naturally welcome, and because of this, rye has been almost universally adopted as a profitable forage crop. Only a few tests of its feeding value, compared with other representative feeds have ever been made. Rye has been used as a soiling crop at this institution every year since the Station was started, but it has only been comparatively recently that a good opportunity for testing its feeding value was offered, as in the spring, before the rye was ready for cutting, the odds and ends of feeds left over from the winter

have been given to the herd, and this afforded a poor basis for comparison. In the spring of 1903 the herd was fed on corn silage up to the time for cutting rye, and as this offered a chance for comparison, the milk yields before and after beginning the feeding of the rye was kept for one week. The comparative results are necessarily given in three divisions, as the cows prior to the feeding of the rye had been used in the feeding tests of cowpea silage, corn silage, and a mixture of corn and cowpea silage. The amounts of milk given for the different periods are given in the following tables:

TABLE No. 15.

## Rye Compared With Cowpea Silage.

| Cow No.                  | Fed Silage<br>lbs. | Fed Rye.<br>lbs. | Daily Aver.<br>on Silage, lbs. | Daily Aver.<br>on Rye, lbs. |
|--------------------------|--------------------|------------------|--------------------------------|-----------------------------|
| 15                       | 147.3              | 88.5*            | 21.0                           | 17.                         |
| 20                       | 117.5              | 105.1            | 16.8                           | 15.0                        |
| 33                       | 127.9              | 113.6            | 18.3                           | 16.2                        |
| 21                       | 83.8               | 82.4             | 12.0                           | 11.8                        |
| 37                       | 107.5              | 86.7             | 15.4                           | 12.4                        |
| 47                       | 111.1              | 96.5             | 15.9                           | 13.8                        |
| 17                       | 71.3               | 26.0             | 10.2                           | 3.7                         |
| Average daily loss ..... |                    |                  |                                | 2.7                         |

TABLE No. 16.

## Rye Compared With Corn Silage.

| Cow No.                  |       |       |      |      |
|--------------------------|-------|-------|------|------|
| 28                       | 154.4 | 143.1 | 22.1 | 20.4 |
| 26                       | 145.2 | 82.6* | 20.7 | 16.5 |
| 58                       | 165.1 | 166.9 | 26.4 | 26.7 |
| 30                       | 101.3 | 107.2 | 14.5 | 15.3 |
| 25                       | 86.2  | 78.8  | 12.3 | 11.3 |
| 38                       | 38.1  | 32.6  | 5.4  | 4.7  |
| 42                       | 93.0  | 89.1  | 13.3 | 12.7 |
| 32                       | 180.4 | 173.7 | 25.8 | 24.8 |
| Average daily loss ..... |       |       |      | 1.0  |

TABLE No. 17.

## Rye Compared With Corn and Cowpea Silage Mixed.

| Cow No.                  |       |        |      |      |
|--------------------------|-------|--------|------|------|
| 31                       | 169.  | 141.1* | 24.2 | 22.8 |
| 27                       | 127.2 | 78.5*  | 18.2 | 15.7 |
| 59                       | 141.7 | 140.6  | 20.2 | 20.1 |
| 35                       | 151.  | 130.3  | 21.6 | 18.6 |
| 41                       | 102.1 | 93.8   | 14.6 | 13.4 |
| 49                       | 67.7  | 59.8   | 12.5 | 8.5  |
| Average daily loss ..... |       |        |      | 2.0  |

The foregoing tables give some food for reflection. If rye were a superior feed to silage, it should certainly show the fact in an increased milk yield, especially as the grain ration was kept up to the amount fed while the cows were receiving silage. But instead of the expected increase there was a sudden and decided decrease in the milk flow. This could not have been due to the advance in lactation period, as the entire time only covered a period of fourteen days—much too short for any radical decrease, from natural causes, in the milk yield. The only possible explanation is that the rye was so much less valuable, as a dairy food, than the silage that it was largely responsible for the loss in milk. This is emphasized by the fact that out of the twenty cows where records are given, eighteen fell off in their milk, and the other two made very little gain.

It seems that the value of green rye has been much overestimated, and that it could be much more profitable to provide silage enough to carry up to a time when a better food than rye could be obtained.

#### EXPERIMENT No. 6.

#### COMPARATIVE VALUE OF RYE AND WHEAT FOR SOILING CROPS.

At this Station, as well as on most farms, where the soiling system is practiced, rye is followed immediately by wheat as a green forage crop, and, as a rule, the wheat is at the right stage for cutting at about the time the rye becomes so hard that cows refuse to eat it. Usually the rye at this Station has been ready to cut for feed about May 1st, or a few days prior to this date. It lasts for from ten days to two weeks, when, though still green, the straw becomes so tough that cattle will not eat it. Fortunately, this is about the time when the wheat commences to head out, and is matured sufficiently to be cut for feed. The wheat in its turn lasts about three weeks longer than the rye, as cattle will eat it until it commences to open. This gives feed until most of the grasses are ready for cutting.

After what has been said in Experiment No. 5, on comparing rye and silage, there would naturally be some interest as to the value of green wheat as a milk producer. To determine the relative value of rye and wheat a table is given, covering the milk yields of a number of the cows in the herd for equal periods during which these feeds were used. (See Table No. 18.)

Rye was fed the first fifteen days of May, and until it had become so hard that the cattle did not seem to care for it, and then wheat was substituted. The wheat lasted a little longer than the rye, but only the first fifteen days during which it was fed are given in the table for comparison.

TABLE No. 18.

Comparison of Rye and Wheat as Soiling Crops.

| Cow No.                          | Period Fed Rye. | Period Fed Wheat. | Gain. |
|----------------------------------|-----------------|-------------------|-------|
| 1                                | 310.            | 318.5             | 8.5   |
| 7                                | 269.2           | 301.8             | 32.6  |
| 12                               | 369.            | 403.8             | 34.8  |
| 13                               | 279.            | 270.5             | 8.5   |
| 15                               | 310.1           | 312.6             | 2.5   |
| 17                               | 277.5           | 303.8             | 26.3  |
| 21                               | 293.3           | 307.2             | 13.2  |
| 22                               | 291.8           | 304.6             | 2.8   |
| 23                               | 241.8           | 234.0             | —7.8  |
| 25                               | 239.6           | 237.5             | —2.1  |
| 26                               | 307.1           | 319.7             | 12.6  |
| 27                               | 275.6           | 282.9             | 7.3   |
| 28                               | 348.6           | 366.7             | 18.1  |
| 29                               | 218.7           | 244.2             | 25.5  |
| 30                               | 237.9           | 241.5             | 3.6   |
| 31                               | 297.4           | 338.1             | 40.7  |
| 32                               | 269.7           | 285.1             | 15.4  |
| 33                               | 223.5           | 259.2             | 35.7  |
| 41                               | 321.9           | 312.4             | —9.5  |
| 42                               | 251.1           | 268.1             | 17.0  |
| Total gain .....                 |                 |                   | 285.7 |
| Average total gain per cow.....  |                 |                   | 14.3  |
| Average daily gain per cow ..... |                 |                   | 1.0   |

As an explanation to the foregoing table, it is necessary to call attention to the fact that most of these cows had been in milk for from five to eight months, and were getting to the point where the milk flow would naturally decrease with time, if the same conditions were maintained. The wheat was fed after the rye, and leaving out of consideration the change in the feed the milk flow should have shown a small decrease during the last period. This makes the increase in the milk flow all the more favorable to the wheat. The table shows that only three fell off in the milk, and seventeen increased their milk flow in varying amounts. This would appear like a very decided proof that of the two feeds wheat was much more valuable than rye.

The relative merits of green wheat compared with dry hay or cut fodder can be approximately determined from the fact that green rye and the dry feeds seem to have about equal feeding value. This makes it quite evident that there need be no hesitation in using wheat in the soiling system in preference to continuing the herd on dry winter feed, as wheat will certainly increase the milk flow of the herd.

In addition to its positive feeding value, wheat has the same advantage as rye in supplying a relatively large quantity of forage from a given acreage, and being out of the way in time to allow the ground to be used for some other crop. It becomes too tough or ripe for a green forage before the middle of June, which allows sufficient time for a crop of corn or cowpeas to mature for silage. This gives practically two large crops from the same piece of land in a single year, and where land is valuable, as in most of the Eastern States, in the dairy districts, the quantity of feed that can be raised on a given area is more to be considered than the extra work in producing this feed.

## EXPERIMENT No. 7.

### SOILING VS. PASTURE.

The greatest consideration in determining whether dairy cows should be pastured or fed soiling crops is one of economy in the greater part of the United States, and a large part of Maryland. This part of the question is particularly to be considered in sections where land is very high. There is no doubt but that more green feed can be raised when the land is pastured. Ten tons per acre would be a liberal estimate of the quantity of green feed growing on a pasture of any mixture of varieties of grasses, while with blue grass, which makes up the bulk of the feed in the best pasturing States, ten tons would be more than could be expected, even for the best of years. With a well-planned system of soiling fifteen tons of green feed can be produced in a season. In some places this amount has been exceeded; in fact, almost doubled. When soiling is practiced, it is possible and advisable to grow more than one crop, even though corn be one of the crops, and corn alone will make twelve tons of green feed on average land in an average year. When cows are pastured it is almost impossible to keep more than a cow to an acre of pasture, and the season of pasturage last seven months in the year. With the soiling system often more than sufficient rough feed is raised on an acre to keep a cow through the entire twelve months of the year. It is the boast of a few dairymen that they have kept a cow to every acre of land, raising sufficient rough feed for the herd, and part of the grain fed, as well as the bedding used. This requires good management, of course, but it has been done by many, and can be done again. The natural fertility of the soil is but a secondary consideration. Where the land is poor in the beginning not so many cows can be kept. But where the products of the land are fed entirely to dairy stock, and the manure is carefully preserved and returned to the land, but a few years are required to bring the soil to a very high state of fertility. Farms devoted entirely to dairying, where the soiling system is followed, soon become very productive. The great amount of humus added to the soil stimulates particularly the growth of the stalk of the various crops planted, and the result is constantly increasing amounts of green feed raised.

The question of soiling is an especially important one in the Southern half of this State, where so much garlic grows in nearly all pasture land. One of the interesting problems connected with soiling is the relative amount of milk a cow will produce under this system, as compared with pasture. Some records on this question were made during the summer of 1901. In the fall of 1899 the Station seeded a 10 1-2 acre piece of land as a permanent pasture. Kentucky Blue, Canada Blue, Orchard, Red-top, Rhode Island Bent White clover and Alsike clover were sown. It was impossible to determine in what proportions these different grasses made up the growing pasture, but there was a good stand of the mixture. In the spring of 1901 the grass was allowed to grow until June 10th, when it was cut for hay. It was then allowed to grow until July 20th, before any stock was turned upon it. The season between the cutting and July 20th, the beginning of the experiment, had been unusually favorable to the growth of grass. It had been warm, and the grass at the end of this period was six to eight inches high, and there was a very thick growth.

Ten cows were used in the experiment. Five were turned on the pasture, and were given no other green food but what they could gather in the pasture from seven in the morning until four in the afternoon. Another lot of five were fed green corn in the barn. This corn was well eared, and was at about the right stage of growth to make the best of feed. These cows were kept in the stable just long enough to eat, and for milking, and during the day had the run of a small woodland, which produced but very little grass. Both lots were turned on this woodland at night. During the experiment both lots had a grain ration of about nine pounds a day. The actual amount of grain fed to each cow in both lots can be seen in Tables Nos. 23 and 24, as well as the amount of green corn eaten by the lot not turned on the pasture.

For seven days previous to commencing this experiment a record was kept of the amounts of grain and green corn eaten by all the cows used in the experiment, and also that of the milk given by each cow. The amounts of feed eaten can be seen in Table No. 19, and the amount of milk given in Table No. 20. The cows were divided into two lots, as fairly as possible, taking the amount of milk given and the amount of time before calving into consideration. As the Station strives to have most of its calves dropped in the fall, the summer is not a favorable time in the period of lactation to carry on experiments in producing milk. As a number of other cattle were turned on this pasture with the five cows under experiment, it did not take long to eat the grass so short as to not furnish sufficient feed for the milking cows. The cows were allowed to remain on the pasture for thirty-five days, and Table No. 21 is computed on the basis of this length of time. As the pasture had been eaten very short some days before this, and the milk yield of the cows had begun to decrease materially, prior to this time a comparison of the milk yields of the two lots for the first twenty-five days was made, and the result can be seen in Table No. 22.

TABLE No. 19.

Feed Eaten by All Cows For One Week Before Turning Into Pasture.

Cows fed green  
corn throughout

| experiment.<br>Cow No. | Total grain<br>eaten lbs. | Total eaten. | Grain per<br>day eaten. | Fodder per<br>day eaten. |
|------------------------|---------------------------|--------------|-------------------------|--------------------------|
| 1                      | 63                        | 385          | 9                       | 55                       |
| 7                      | 63                        | 385          | 9                       | 55                       |
| 27                     | 63                        | 378          | 9                       | 54                       |
| 31                     | 63                        | 378          | 9                       | 54                       |
| 58                     | 63                        | 434          | 9                       | 63                       |
| Average .....          |                           |              | 9                       | 56                       |

Cows turned on  
pasture in ex-  
periment.

| Cow No.       |    |     |   |    |
|---------------|----|-----|---|----|
| 17            | 63 | 406 | 9 | 58 |
| 28            | 63 | 448 | 9 | 64 |
| 32            | 63 | 385 | 9 | 55 |
| 35            | 63 | 385 | 9 | 55 |
| 42            | 63 | 420 | 9 | 60 |
| Average ..... |    |     | 9 | 58 |

TABLE 20.

Milk Given by all Cows for Seven Days Before Beginning the Experiment.

| Cows turned on<br>pasture during<br>experiment.<br>Cow No. | Total milk<br>given lbs. | Milk per<br>day, lbs. |
|--|--------------------------|-----------------------|
| 17   | 117.8                    | 16.8                  |
| 28   | 132.6                    | 18.9                  |
| 32   | 103.1                    | 14.7                  |
| 35   | 93.9                     | 13.4                  |
| 42   | 106.3                    | 15.2                  |
| Average .....  | 110.7                    | 15.8                  |
| Cows fed green<br>corn during<br>experiment.               |                          |                       |
| 1  | 102.6                    | 14.7                  |
| 7  | 102.2                    | 14.6                  |
| 27   | 110.2                    | 15.7                  |
| 31   | 112.8                    | 16.1                  |
| 58   | 108.1                    | 15.4                  |
| Average .....  | 107.2                    | 15.3                  |

TABLE No. 21.

Milk Given by Cows During 35 Days of Experiment.

| Cows turned on<br>pasture.<br>Cow No. | Total milk.<br>lbs. | Av. daily<br>milk lbs. |
|---------------------------------------|---------------------|------------------------|
| 17                                    | 611.9               | 17.5                   |
| 28                                    | 597.1               | 17.1                   |
| 32                                    | 552.5               | 15.8                   |
| 35                                    | 537.6               | 15.4                   |
| 42                                    | 607.6               | 17.4                   |
| Average .....                         |                     | 16.6                   |
| Cows fed<br>green corn.<br>Cow No.    |                     |                        |
| 1                                     | 480.3               | 13.7                   |
| 7                                     | 525.0               | 15.0                   |
| 27                                    | 525.0               | 15.0                   |
| 31                                    | 532.9               | 15.2                   |
| 58                                    | 506.7               | 14.5                   |
| Average .....                         |                     | 14.7                   |

TABLE No. 22.

Milk Given by Cows in 25 Days From Beginning of Experiment.

| Turned on pasture.<br>Cow No. | Total milk.<br>lbs. | Milk per<br>day, lbs. |
|-------------------------------|---------------------|-----------------------|
| 17                            | 448.8               | 17.9                  |
| 28                            | 448.9               | 17.9                  |
| 32                            | 416.4               | 16.7                  |
| 35                            | 402.8               | 16.1                  |
| 42                            | 439.5               | 17.6                  |
| Average .....                 |                     | 17.2                  |

Cows fed green  
corn.

| Cow No.       |       |      |
|---------------|-------|------|
| 1             | 352.8 | 14.1 |
| 7             | 374.1 | 15.0 |
| 27            | 380.5 | 15.2 |
| 31            | 394.3 | 15.8 |
| 58            | 361.9 | 14.5 |
| Average ..... |       | 14.9 |

TABLE No. 23.

Grain Eaten by Cows in 35 Days They Were on Pasture.

| Cow No. | Total Grain.<br>lbs. | Grain per<br>day, lbs. |
|---------|----------------------|------------------------|
| 17      | 315.                 | 9                      |
| 28      | 315.                 | 9                      |
| 32      | 300.                 | 8.5                    |
| 35      | 315.                 | 9                      |
| 42      | 315.                 | 9                      |

TABLE No. 24.

Grain and Fodder Eaten by Cows Kept in Stable.

| Cow No. | Total<br>grain lbs. | Total<br>fodder lbs. | Grain per<br>day lbs. | Fodder per<br>day lbs. |
|---------|---------------------|----------------------|-----------------------|------------------------|
| 1       | 315                 | 2042                 | 9                     | 58.3                   |
| 7       | 315                 | 2050                 | 9                     | 58.5                   |
| 27      | 315                 | 2011                 | 9                     | 54.6                   |
| 31      | 315                 | 2011                 | 9                     | 54.6                   |
| 58      | 315                 | 2185                 | 9                     | 62.4                   |

It will be noted from Tables Nos. 20 and 22 that the cows on pasture increased in their average daily yield of milk from 15.8 pounds, before turning on pasture, to 17.2 pounds after turning on pasture—a gain of 1.4 pounds per day. The cows which were fed green corn during the experiment produced an average of 15.3 pounds of milk before beginning the experiment, and an average of 14.9 pounds of milk per day during the twenty-five days of the experiment—a loss of .4 pounds per day. Adding this loss to the 1.4 pounds gain in yield of the cows turned on pasture makes a total of 1.8 pounds of milk per day in favor of the pasture as compared with the green corn. It is very likely that, as a rule, cows turned into a field of grass to graze will produce a little more milk than they would produce were they fed the same grass cut and fed green to them in their stalls. Why this should be so is something of a mystery. It would be difficult to compare the actual value of the feeds given to the two lots of cows for the production of milk. However, it is entirely practicable to feed enough better food under the soiling system to fully compensate for the difference in favor of pasturing. The pasture which we used was particularly good, with an unusual luxuriant growth of grass containing considerable clover. Ordinarily, pastures contain only Kentucky blue grass, which would not be as good, and would not produce as much milk as did the pasture used in this particular instance.

Grain is fed the entire year at the Station, as better cows undoubtedly result, even though no beneficial results can be seen at the time. In other words, comparative tests might not show that cows receiving grain were giving enough more milk to pay for the grain eaten, but it would show in the increased value of the cow the following year. It is possible, however, that in these trials, the details of which have been given in the foregoing tables, more grain was fed to the cows on pasture than was needed or profitable. It seemed, however, that the fairness of the test of the two methods of feeding required that both lots of cows should receive the same quantity of grain.

### EXPERIMENT No. 8.

#### COMPARISON OF DRY FEED AND PASTURE.

The value of good pasture over dry feed for dairy cows was well illustrated at this Station in the spring of 1903. Seven cows which had been fed with cut corn fodder, of medium quality, as the bulk of rough feed, were turned on a fairly good blue grass, white clover pasture about May 1st. These cows, previous to turning on the pasture, had received all the cut fodder they would eat, with a little silage, every evening, and from eight to twelve pounds of a mixture of bran, gluten meal and hominy chop per day—a rather heavy grain ration. These cows had calved from three to seven months before turning on pasture. The udders of all of them had become shrunken and flabby, as in a cow that has passed her highest milk yield, and was slowly approaching the end of her milking period. Everything pointed to a

continued steady decrease in the milk flow. The following table shows the milk yield of each of the seven cows for the month before, and the month following turning on pasture.

TABLE No. 25.

## MILK YIELD OF COWS ON DRY FEED AND PASTURE.

| Cow No.                         | Milk yield for<br>April, pounds<br>dry feed | Milk yield for<br>May, pounds,<br>pasture. | Gain Produced<br>by pasture,<br>pounds. |
|---------------------------------|---|--|---|
| 12                              | 418.2                                       | 623.8                                      | 205.6                                   |
| 15                              | 585.9                                       | 818.4                                      | 232.5                                   |
| 26                              | 497.1                                       | 506.6                                      | 9.5                                     |
| 27                              | 557.5                                       | 813.7                                      | 256.2                                   |
| 29                              | 543.0                                       | 601.6                                      | 58.6                                    |
| 31                              | 504.9                                       | 635.5                                      | 130.6                                   |
| 36                              | 248.3                                       | 347.5                                      | 99.2                                    |
| Average daily gain per cow..... |   |  | 4.7                                     |

One of the most interesting things connected with this work was the amount of grain eaten by these cows during the two periods. As was noted, from eight to twelve pounds per day were fed to these cows during April. It was the intention to feed these cows a liberal ration after they were turned on grass, but as soon as they were turned in the pasture they refused to eat all the grain given, and in a week they were eating only three pounds per day per head, which quantity was all any one of the number would clean up.

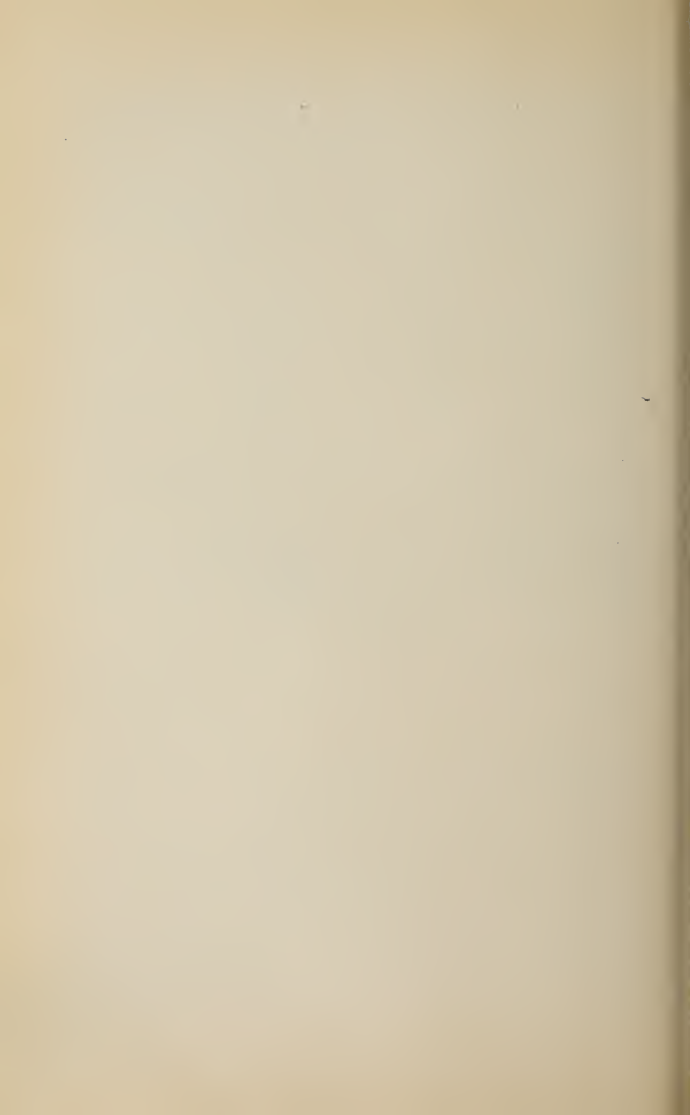
An interesting thing was noted with Cows 15, 27 and 31, after they were turned on to grass. Their udders, which had become loose and shrunken, immediately commenced to swell up, and at the end of two weeks they appeared like cows that had recently calved. No. 15 had been in milk for seven months, No. 27 for three months, and No. 31 for five months.

In the table giving the yields there is abundant material for reflection and theorizing. Three cows, 12, 15 and 27, made almost abnormal increases in their milk yields. How cows which had been milked for several months, and had received during that time what would be called by most dairymen a liberal quantity of good feed, could almost double their milk flow, as these cows did for a few days, is astonishing, and this was done, too, with about one-fourth the grain. One is led to wonder what would have been the ultimate results had these cows had as good pasture for the entire period after calving. Would they have given more during May than they did? Is it possible for a cow to come back to her full flow of milk after she has materially decreased that flow? If not, there is room for speculation as to what these cows might have done in the line of milk and butter production could they have had as good pasture from the time of calving.

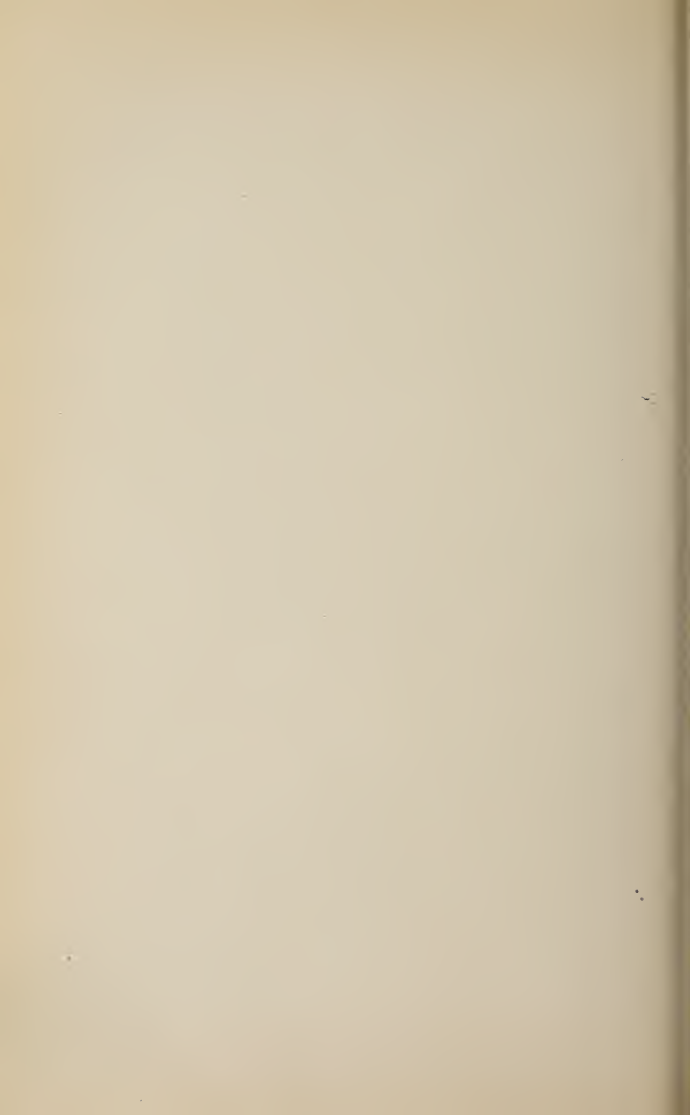
This experience emphasizes one fact,—that rough feed can play a very great part in milk production. To put it in other words, the proper kind of rough feed is more necessary than plenty of grain. The cows used in this test were getting a maximum ration of what are known as the very best dairy foods. They were also getting what most farmers would call a very fair kind of rough feed. They certainly relished their cut corn fodder, for they were eating all that a cow could be expected to eat. But when the rough feed was changed, these cows not only normally increased their milk flow, but did it with much less grain.

A question which naturally arises is, why a cow will give more milk when allowed to eat grass in a pasture than when this same grass is cut and fed in the stall? From our work it would seem that this is so. Two variations occur in the two different ways of feeding. In one the cow usually receives all of her forage in two feeds per day; in the other she may put in a large share of the day gathering her feed. In one case the feed may be slightly wilted, while in the other it is, of course, eaten perfectly fresh. It is hard to see, however, how either of these would materially affect the milk. There seems to be a chance for some experimental work for determining the best method of feeding soiling crops. There might be a chance for improving the custom of feeding twice a day only.

In view of the results given in these pages it may cause some hesitancy on the part of many whether to take up soiling in preference to pasturing, when only the milk yield is considered; but it must be remembered that the quantity of feeds obtained per acre, and consequently the number of cows which can be kept on a given area, are much in favor of the soiling system.











# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

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Bulletin No. 99.

December, 1904.

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## Test of Different Spraying Materials for the Control of San Jose Scale.

By Thos. B. Symons.

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It has been proven beyond a doubt that by proper spraying the San Jose scale can be kept under control, and that not only can the trees which are affected by this pest, be saved, but that they can be made to grow profitable crops.

The profits which have come, the past year, from those orchards which have been thoroughly and systematically sprayed have been very encouraging to the owners, and also attracted much attention; so that it is probable that spraying will be more largely and thoroughly followed in the future than ever before.

As reported in Bulletin No. 90, there is no doubt but that the lime, sulphur and salt solution, when properly applied, will kill most all the scale, and make the trees otherwise more healthy and productive, and, from this standpoint alone, would seem to be about all that could be desired; yet as the solution is troublesome to prepare, and disagreeable to apply, there has been an effort to secure something to overcome these objections and, consequently, there have been a great number of materials placed on the market claiming to meet this demand and to possess other superior qualities.

In order to be able to answer the many inquiries as to the value of the various spraying solutions, and to determine some other points which are in doubt, a series of experiments were conducted during the past year, and the results obtained are reported in the following pages.

The following tests were made the past season:

1. Tests of various formula and methods of making the lime, sulphur and salt solution.

2. Tests of caustic soda and potash solutions.
3. Tests of various "patented" or "trade mark" insecticides.
  - a. "San Jose exterminator."
  - b. "Consol."
  - c. "Webcide."
  - d. "Kil-o-scale."
4. Test of spraying at different seasons.
  - a. Late fall and early winter applications.
  - b. Early spring applications.
  - c. Summer applications.

In these tests twenty-eight different solutions were used, and they were applied on 1,260 trees. All of the trees used in the experiments were badly infested with scale. The experiments were conducted in the orchards belonging to the following people:

Philip Edwards, Bengies, Baltimore county, Md.  
 Wm. S. Powell, Annapolis Junction, Howard county, Md.  
 H. B. McDonnell, College Park, Prince George's county, Md.  
 T. L. Basford, Savage, Howard county, Md.  
 R. R. Lewis, Frederick, Frederick county, Md.  
 H. J. Beard, Feagaville, Frederick county, Md.  
 J. A. Richardson, Cavetown, Washington county, Md.  
 Wm. F. Dashfield, Taylor's Island, Dorchester county, Md.  
 A. T. Barnes, Taylor's Island, Dorchester county, Md.  
 Henry W. Shinton, Taylor's Island, Dorchester county, Md.

We are much indebted to the above-named gentlemen for the use of their orchards for this work, and for the many other ways in which they co-operated.

Credit is due to Messrs. F. C. Bishopp and A. B. Gahan, Assistant Entomologists, and Messrs. W. C. Travers and H. J. Beard for their part in conducting the details of the experiments.

The details of these experiments are given in tables Nos. 1, 2, 3 and 4.

### RESULTS OBTAINED.

The results obtained in the main were quite satisfactory and conclusive; yet in some instances the conditions which prevailed at the time the sprays were applied prevented their proper action, and, consequently, due allowance must be made in such cases.

For details as to the formulas used, manner of preparation, etc., see tables Nos. 1, 2, 3 and 4. From these tables we will see:—

1st. The various combinations of lime, sulphur and salt gave good results.

2nd. That it would seem to be advisable to have at least twenty pounds of lime and fifteen pounds of sulphur to each fifty gallons of water.

3d. That the cooked solutions seemed to give better results than the uncooked.

4th. That after the portion of the solution had been cooked it may be diluted with either hot or cold water.

5th. That the use of boiling water to slack the lime, with the sulphur and salt added at the same time, gave good results. The work involved in this method proved to be as great as when the whole was boiled.

6th. The lime and sulphur formulas (without salt) gave good results in some cases, but not in others, and do not warrant definite conclusions without further tests.

7th. The addition of caustic soda or potash to the lime and sulphur solution seemed to be an advantage, particularly when it was not cooked.

8th. The caustic soda solutions, of the strengths used, killed a large number of scale, yet they were not effective in controlling the scale.

9th. None of the patented insecticides proved effective in killing the scale, and as these materials are made at present they cannot be recommended. See tables Nos. 2, 3 and 4.

### TIME OF APPLICATION.

In studying the time of applying the spray the aim was to determine whether the effect of the solution was more potent at one season than at another, and to test the relative lasting qualities of the different solutions.

In spraying, the first object is to do the work at the season and under the conditions which will give the best results, but other things being equal, the farmer will prefer to do this class of work at the time of the year when there is no other pressing work.

### LATE-FALL AND EARLY-WINTER APPLICATIONS.

The plan was to apply, in the early fall, the different sprays usually employed, but circumstances prevented some of the work being done until January, 1904. The object of these tests was to ascertain the effect of the sprays when used at this season. Table No. 1 gives a list of these experiments. Two or three trees, which were sprayed on December 11th and 15th, 1903, with the Standard Lime, Sulphur and Salt Solution, showed poor results, but this was probably due to the fact that they were very badly infested, and that there was a strong wind, which prevented thorough spraying, and also to the heavy rain which immediately followed the spraying.

On the whole, the results would seem to indicate that the lime, sulphur and salt spray may be used in the late fall and early winter with as good results as at any other season.

### EARLY-SPRING APPLICATIONS.

The spring applications gave very good results, and, on the whole, seemed to be the most favorable time for applying the spray;

yet the advantage of the spring applications over the fall and winter applications was not sufficient to warrant deferring the work if the earlier dates were more convenient.

For detailed results see table No. 2.

### SUMMER APPLICATIONS.

It was the intention to test a number of materials, with the idea of securing one that could be applied with safety about the season when the young are crawling, but other pressing work prevented the taking up of this work on as large a plan as was expected. However, tests were made of two of the patented insecticides which were advocated for spraying at that time, and, for comparison, some trees were sprayed with full and half-strength solutions of lime, sulphur and salt. The detailed results are given in table No. 4, from which it will be seen that the lime, sulphur and salt solutions gave poor results and caused loss of foliage of the trees.

The "Kil-o-scale" applied June 18th injured the foliage of the trees considerably and had no effect on the scale, but the same trees were sprayed on September 24th with a modified "Kil-o-scale," which killed the scale but injured the trees. Until these difficulties are overcome this spray cannot be recommended.

"Webcide" did not kill the scale and did not injure the foliage. It has nothing to recommend it for destroying the San Jose scale.

### RECOMMENDATIONS.

In view of the results recorded in this bulletin, and the observations made in the various parts of the State, there seems to be no spray that can be recommended for the control of the San Jose scale, except the lime, sulphur and salt solutions.

The following solution would seem to be the best that can be recommended:

|   |             |
|---|-------------|
| Good quality of freshly burnt stone lime..... | 20 pounds.  |
| Flowers of sulphur .....                      | 15 pounds.  |
| Common salt. ....                             | 10 pounds.  |
| Water.....                                    | 50 gallons. |

### DIRECTIONS FOR MAKING SOLUTION.

Put twenty gallons of water in an iron pot or hog scald and bring it to a boil, and then add the stone lime and sulphur. The sulphur should be made into a paste with hot water before placing it in the boiler in order to facilitate its mixing. After the lime and sulphur have boiled for a few minutes add the salt. Boil the mixture, stirring occasionally, from thirty minutes to one hour, or until the sulphur is thoroughly dissolved and produces a clear amber-colored solution. Then dilute by adding sufficient water to make fifty gallons. Pass the mixture through a strainer, with at least twenty meshes to the inch, into the spray barrel, and apply to the trees warm.

The mixture may be diluted with either hot or cold water, but as the solution sprays better warm it is wiser to use the hot water, though the cold water has given very satisfactory results.



FIG. 1.—CONVENIENT OUTFIT FOR BOILING THE WASH. (After Britton and Waldon. Bulletin 146, Conn. Expt. Station).

### SOLUTION WITHOUT COOKING.

When it is impracticable to cook the solution, as described above, one can be made as follows, without cooking, which will be fairly effective:

|                          |             |
|--------------------------|-------------|
| Stone lime.....          | 30 pounds.  |
| Flowers of sulphur ..... | 15 pounds.  |
| Caustic soda .....       | 8 pounds.   |
| Water....                | 50 gallons. |

Dissolve the caustic soda in water and stir into it the sulphur which has previously been made into a paste, then use this solution for slacking the lime. Slack the lime just as it should be for a good whitewash, then dilute the whole to fifty gallons, and strain into a barrel and use at once.

### TIME FOR SPRAYING.

The lime, sulphur and salt solutions may be applied at any season during the dormant period of the tree from late fall to early spring, but the preferable time is the early spring.

## MODE OF APPLICATION.

For applying the solution select a good spray pump that has all its working parts brass and furnishes a constant high pressure. Use any of the nozzles that are suitable for applying the Bordeaux mixture. An outfit such as shown in Fig. 2 is a very convenient equipment for the purpose.



FIG. 2.—CONVENIENT OUTFIT FOR USE IN THE ORCHARD. (After Britton and Waldon, Conn. Bulletin 146).

The spraying is somewhat disagreeable, and the solution is slightly corrosive so that the man doing the work should be provided with rubber or oil-skin coat, hat and gloves and a pair of goggles. It is a good plan to rub some vaseline on the hands and face to prevent the spray from irritating the flesh. The horses should be covered with blankets or old sacks. The aim should be to spray thoroughly and to see that every part of the tree is covered. In order that this may be done with facility, the hose should be long enough to enable the men to reach all sides of the tree without moving the barrel. Trees which have been thoroughly sprayed present a whitened appearance when dry. After drying it is easy to detect any parts that have been missed.

There are a great many kinds of spray pumps and outfits on the market, and each person must select that which suits his taste and needs.

The following are manufacturers and dealers in pumps and supplies:

Griffith & Turner Co., Baltimore, Md.  
Gould's Mfg. Co., Seneca Falls, N. Y.  
The Deming Co., Salem, O.  
Morril & Morley, Benton Harbor, Mich.  
Field Force Pump Co., Elmira, N. Y.  
Myers Pump Co., Ashland, O.  
Geo. H. Stahl, Quincy, Ill.  
Spray Motor Co., Buffalo, N. Y.  
L. H. Orndorff, 203, 7th street, Washington, D. C.  
F. W. Bolgiano & Co., 935 B street, Washington, D. C.

TABLE 1.—EXPERIMENT WITH APPLICATIONS MADE IN LATE-FALL AND EARLY-WINTER CONDUCTED AT BENGIES, MD., ON PEACH TREES.

| No. of Trees. | Kind of Spray.                    | Formula.  | Manner of Preparation.                               | Time of Application. | Results.* | Remarks.   |
|---------------|-----------------------------------|---|--|----------------------|-----------|--|
| 70            | Lime, sulphur and salt.           | Lime, 30 lbs.<br>Sulphur, 16 lbs.<br>Salt, 12 lbs.<br>Water, 50 gal.  | Cooked $\frac{1}{2}$ hr. and diluted with hot water. | Dec. 11, 1903.       | Fair.     | Strong wind at time of spraying, immediately followed by rain.                           |
| 30            | Lime, sulphur and salt.           | "   | Made without cooking. All materials added at once.   | "                    | Good.     | Conditions unfavorable.  |
| 30            | Lime, sulphur and salt.           | "   | Cooked 1 hr., diluted with hot water.                | Dec. 12, 1903.       | Good.     |  |
| 30            | Lime, sulphur and salt.           | "   | Cooked $\frac{1}{2}$ hr., diluted with hot water.    | "                    | Good.     |  |
| 30            | Lime, sulphur and salt.           | Lime, 15 lbs.<br>Sulphur, 15 lbs.<br>Salt, 8 lbs.<br>Water, 50 gal.   | Cooked 1 hr., diluted with hot water.                | Dec. 15, 1903.       | Good.     | Heavy rain fell immediately after spraying.  |
| 30            | Lime and sulphur.                 | Lime, 30 lbs.<br>Sulphur, 16 lbs.<br>Water, 50 gal.                   | Cooked 1 hr., diluted with hot water.                | Dec. 23, 1903.       | Fair.     | Condition at time of spraying unfavorable.   |
| 30            | Lime and sulphur.                 | "   | Not cooked, diluted with cold water.                 | Jan. 1, 1904.        | Poor.     |  |
| 30            | Lime, sulphur and caustic potash. | Lime, 35 lbs.<br>Sulphur, 17 lbs.<br>Potash, 4 lbs.<br>Water, 50 gal. | Not cooked, diluted with cold water.                 | Dec. 25, 1903.       | Fair.     |  |
| 30            | Caustic soda.                     | 7 lbs. to 50 gal. water.  | Dissolved soda in hot water.                         | Jan. 1, 1904.        | Very poor | Did no damage to trees except in one case and that was probably due to some other cause. |

\*Based on four examinations of trees made during December, February, April, August and September. Besides killing the scale the effect on the trees was good.

TABLE 2.—EXPERIMENTS WITH APPLICATIONS MADE IN THE EARLY-SPRING.

| Place.           | No. Trees. | Kind of Trees.   | Kind of Spray.          | Formula.  | Manner of Preparation.                             | Time of Application. | Results.*    | Remarks. |
|------------------|------------|------------------|-------------------------|---|--|----------------------|--------------|----------|
| Taylor's Island. | 87         | Peach.           | Lime, sulphur and salt. | Standard.   | Cooked 1 hr., diluted with hot water.              | Mar. 30, 1904.       | Very good.   |          |
| "                | 76         | "                | "                       | "   | No cooking, diluted with cold water.               | Mar. 30, 1904.       | Good.        |          |
| "                | 97         | "                | "                       | Lime, 20 lbs. Sulphur, 16 lbs. Salt, 12 lbs.                                      | Cooked 1 hr., diluted with hot water.              | Mar. 30, 1904.       | Very good.   |          |
| "                | 95         | "                | "                       | Water, 50 gal. Lime, 15 lbs. Sulphur, 15 lbs. Salt, 12 lbs.                       | Cooked 1 hr., diluted with hot water.              | Mar. 30, 1904.       | Fairly good. |          |
| Annapolis Junc.  | 50         | Apple.           | "                       | Water, 50 gal. Standard.  | No cooking, lime slacked in hot water.             | Mar. 26, 1904.       | Fairly good. |          |
| "                | 30         | "                | "                       | "   | Cooked $\frac{1}{2}$ hr., diluted with cold water. | Mar. 24, 1904.       | Fairly good. |          |
| College Park...  | 7          | Apple and peach. | "                       | "   | No cooking, lime slacked in hot water.             | Mar. 24, 1904.       | Good.        |          |
| Taylor's Island. | 37         | Peach.           | Lime and sulphur.       | "Standard" and 4 lbs. caustic soda. Lime, 30 lbs. Sulphur, 15 lbs. Water, 50 gal. | Cooked 1 hr., diluted with hot water.              | Mar. 30, 1904.       | Very good.   |          |
| Thurmont.....    | 25         | "                | "                       | Lime, 35 lbs. Sulphur, 16 lbs. Water, 50 gal.                                     | Cooked $\frac{1}{2}$ hr., diluted with hot water.  | April 21, 1904.      | Fair.        |          |

\*Based on examinations made in June, August and September.

TABLE 2.—Continued.

| Place.                | No. Trees. | Kind of Trees.  | Kind of Spray.                  | Formula.   | Manner of Preparation.                  | Time of Application. | Results.*  | Remarks.  |
|-----------------------|------------|-----------------|---------------------------------|--|---|----------------------|------------|---|
| Thurmont, . . . .     | 30         | Peach.          | Lime and sulphur.               | Lime, 15 lbs.<br>Sulphur, 15 lbs.<br>Water, 50 gal.                        | Cooked 1 hr., diluted with hot water.   | April 21, 1904       | Poor.      |   |
| "                     | 20         | "               | Lime, sulphur and caustic soda. | Lime, 40 lbs.<br>Sulphur, 15 lbs.<br>Caustic soda, 4 lbs.                  | Cooked 10 m., diluted with cold water.  | April 19, 1904.      | Fair.      |   |
| Bengies, . . . . .    | 15         | "               | "                               | Water, 50 gal.<br>Lime, 30 lbs<br>Sulphur, 16 lbs.<br>Caustic soda, 6 lbs. | Cooked 14 hrs., diluted with hot water. | April 6, 1904.       | Good.      |   |
| Annapolis Junc.       | 100        | "               | "                               | Water, 50 gal.   | Without cooking.                        | Mar. 2, 1904.        | Poor.      | Conditions not favorable.                         |
| Bengies, . . . . .    | 15         | "               | Caustic soda.                   | 5 lbs to 50 gal. water.  | Soda dissolved in hot water.            | April 6, 1904.       | Very poor. | Same trees that were sprayed with soda in winter. |
| "                     | 15         | "               | "                               | 7 lbs. to 50 gal. water.   | "                                       | April 6, 1904.       | "          |   |
| Annapolis Junc.       | 7          | Apple.          | "                               | 6½ lbs. to 50 gal. water.  | "                                       | Mar. 2, 1904.        | "          |   |
| Cavetown, . . . . .   | 5          | Apple and plum. | "                               | 8½ lbs. to 50 gal. water.  | "                                       | Mar. 25, 1904        | "          |   |
| Feagaville, . . . . . | 5          | Apple.          | "                               | 8 lbs. to 50 gal. water.   | "                                       | Mar. 20, 1904        | "          |   |
| Taylor's Island.      | 20         | "               | "                               | 7 lbs. to 50 gal. water.   | "                                       | April 23, 1904.      | "          | Some trees injured severely.                      |

Based on examinations made in June, August and September.

TABLE 3.—TESTS OF PATENTED INSECTICIDES APPLIED IN THE SPRING AND EARLY-SUMMER. (EXPERIMENTS CONDUCTED ON APPLE TREES).

| Place.           | No. of Trees. | Kind of Spray.         | Strength of Spray.       | Time of Application. | Results.*  | Remarks. |
|------------------|---------------|------------------------|--------------------------|----------------------|------------|----------|
| Annapolis Junc.  | 10            | San Jose Exterminator. | 1 gal. to 50 gal. water. | March 23, 1904.      | Very poor. |          |
| Savage.....      | 10            | "Con-sol."             | 1 gal. to 4 gal. water.  | April 30, 1904.      | Very poor. |          |
| Taylor's Island. | 2             | "                      | "                        | May 12, 1904.        | Poor.      |          |
| Savage.....      | 10            | "Webcide."             | 1 gal. to 30 gal. water. | April 30, 1904.      | Very poor. |          |
| Savage.....      | 10            | "                      | "                        | June 30, 1904.       | Very poor. |          |
| Savage.....      | 15            | Kil-o-Scale.           | "                        | April 30, 1904.      | Very poor. |          |

\*Based on three examinations.

TABLE 4. — EXPERIMENTS WITH APPLICATIONS MADE IN THE SUMMER.

| Place.        | No. Trees. | Kind of Trees. | Kind of Spray.          | Formula.   | Manner of Preparation.   | Time of Application. | Results.*    | Remarks.                                      |
|---------------|------------|----------------|-------------------------|--|--------------------------|----------------------|--------------|---|
| Frederick ..  | 35         | Apple.         | Lime, sulphur and salt. | Lime, 30 lbs.<br>Sulphur, 16 lbs.<br>Salt, 12 lbs.<br>Water, 50 gal.                           | Made in usual manner.    | July 8, 1904.        | Poor.        | Conditions unfavorable; defoliated the trees. |
| Bengies . . . | 15         | Peach.         | "                       | "  | "                        | Aug. 20, 1904.       | Poor.        | Trees injured, but not seriously.             |
| " . . .       | 15         | "              | "                       | Lime, 15 lbs.<br>Sulphur, 8 lbs.<br>Salt, 6 lbs.<br>Water, 50 gal.<br>1 gal. to 20 gal. water. | "                        | Aug. 20, 1904.       | "            | Trees injured, but not seriously.             |
| Savage.....   | 10         | Apple.†        | Webcide.                | 1 gal. to 20 gal. water.   | Diluted with cold water. | June 30, 1904.       | Very poor.   |   |
| " . . . . .   | 10         | "              | Kil-o-Scale             | 1 gal. to 20 gal. water.   | Diluted with cold water. | June 18, 1904.       | "            | Foliage slightly injured.                     |
| " . . . . .   |            | "              | "                       | 1 gal. to 10 gal. water.   | Diluted with cold water. | Sept. 24, 1904.      | Scale killed | Trees injured.                                |
| " . . . . .   |            | "              | "                       | 1 gal. to 15 gal. water.   | Diluted with cold water. | "                    | "            | "   |
| " . . . . .   |            | "              | "                       | 1 gal. to 20 gal. water.   | Diluted with cold water. | "                    | "            | Trees slightly injured.                       |

†Kil-o-Scale. (Modified since that used June 19th.)

\*Based on examination made in July and September.

†Same trees that were sprayed with these solutions in the Spring.

# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

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## THE WILD LEGUMES OF MARYLAND AND THEIR UTILIZATION.

By J. B. S. Norton and E. P. Walls.

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The value to the soil of the cultivated leguminous plants has long been recognized and they are now being used extensively, aside from their great feeding value, for adding to the nitrogen and humus content of the land.

The wild plants of this kind, next to the grasses and composites, form a larger part of our native flora than any other family of plants, and since many of them are closely related to the kinds doing best under cultivation it is reasonable to suppose that some of the wild species are of value in the same manner as the cultivated ones. It is the design of this bulletin to furnish a list of the leguminous plants found wild in this State, showing the localities and kinds of soil and surroundings where they grow best, and indicating the ways in which they may be utilized, with suggestions as to the possible improvement of the more valuable species, experiments along this line being in progress now at this Experiment Station.

Extensive collections and observations over the State as well as all available herbaria and published records have been used as the basis of this work. In addition to our own observations some of the notes on uses, etc., have been taken from various standard works.

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### UTILIZATION.

The most valuable use of the wild legumes is in improving soil by means of nitrogen compounds produced in them from the assimilation of free atmospheric nitrogen in the nodules on their roots. For this reason their protein content is unusually high and they also then make most useful feeding stuffs. A few are trees and have valuable wood. Some have very ornamental flowers, while a few are bad weeds or even poisonous.

## RELATION OF LEGUMINOUS PLANTS TO SOIL FERTILITY.

There seems to be an erroneous belief among those not thoroughly conversant with the subject, that a legume will increase the fertility of any soil, by taking up nitrogen from the air, regardless of prevailing conditions, and previous treatment of the soil; and that all green manuring crops are legumes. Therefore at the beginning it may be well to explain the soil conditions which are necessary in order that legumes may gather nitrogen from the air, and also make a distinction between those green manuring crops which gather atmospheric nitrogen, and those which either consume or only convert the soil nitrogen, or, strictly speaking, the leguminous and non-leguminous green manures.

In order that a legume may assimilate nitrogen from the atmosphere, the soil must primarily contain or be inoculated with certain bacteria, whose presence is manifested by the growth of nodules on the roots, through which it is believed that the atmospheric nitrogen is obtained. These germs are usually found abundantly in most well-tilled soils.

Any crop may serve as a green manure, but leguminous crops possess a greater value for this purpose, than others, because they can obtain certain of their constituents from sources not accessible to all plants. Therefore in order to show the value of legumes as green manure, it is necessary here to separate them from other green manuring crops, which, instead of increasing the supply of soil nitrogen, actually decreases it.

## FERTILIZING POWER OF LEGUMINOUS AND NON-LEGUMINOUS PLANTS.

The most important legumes available for use as green manures, are crimson clover, red clover, cow peas, and soja beans. They are not only valuable on account of their nitrogen-gathering property, but their period and time of growth make them very convenient crops. The quantity of nitrogen which these crops gather from the air, depends largely on the amount of nitrogen stored in the soil, for they will gather at least a part of their nitrogen from the soil, in preference to that of the air, unless starved of soil nitrogen. Therefore the exact amount of nitrogen which a plant gathers from the air, cannot be determined by the content of nitrogen in the plant. But it has been determined by experiment that they do gather nitrogen from the air, and store it in their own tissues which, by decaying, allow it to be used by other crops, which can obtain this valuable element only from the soil. For this reason, they can, by judicious growing, be made a very potent factor in the economical production of crops.

The principal non-leguminous green manures are rye, buckwheat and mustard. They do not increase the supply of soil nitrogen, but by their time of growth, prevent the loss of this element by leaching, which is very liable to occur if the soil is left naked. They improve the mechanical and physical condition of soils, and conserve the soil nitrogen. But while they retain the supply of nitrogen in the soil, they convert it from the immediately available to the less available organic

form. Therefore while the practice of growing these non-leguminous crops as green manures, is desirable, if wisely followed, it should be



Fig. 1—Soy Bean—After Abel, Farmers' Bulletin 121, United States Department of Agriculture.

remembered that they do not add plant food to the soil, but only increase the organic matter.

#### TUBERCLE PRODUCING BACTERIA AND METHODS OF SOIL INOCULATION.

It has been stated above that in order for a legume to utilize the atmospheric nitrogen, a certain germ or bacterium must be present on the roots. This germ enters the young roots, and after locating itself, causes a multiplication of cells around it which produces the tubercles seen on such roots. This mass of cells remains soft and succulent, in comparison with the rest of the roots, and is always sufficiently porous to admit the atmospheric nitrogen, which is abundant in all well cultivated soils. The exact means by which the bacteria place the nitrogen of the atmosphere at the disposal of the plant is not thoroughly understood, but it is known that the tubercles are the dwelling places of the germs, through which the atmospheric nitrogen reaches the plant.

Because of the fact frequently observed that one kind of legume would not produce nodules in soil which abundantly supplied another legume with these growths, it has been supposed that each legume required a special and peculiar nodule organism.

Efforts have been made to distinguish between these bacteria specifically, and separate names have been assigned to the microbes from nodules of peas, beans, clover, etc. Most investigators, however,



Fig. 2.—Peanut—After Abel, Farmers' Bulletin 121, United States Department of Agriculture.

have been unable to discover any constant difference in the appearance and general characteristics of the bacteria of the various legume nodules, and the results of the most recent research on this question seem to prove that there is only a difference in variety and not in species.

Dr. Geo. T. Moore, of the United States Department of Agriculture, Washington, D. C., in laboratory experiments, succeeded in producing nodules on a large number of legumes by inoculation with a single culture. As a result of a great many cross-inoculations, made in every possible combination, Dr. Moore concludes, "that it was satisfactorily demonstrated that it is possible to cause the formation of nodules upon practically all legumes no matter what the source of the original organisms." Nevertheless, it is certainly true that the bacteria seem to adapt themselves to the conditions surrounding the growth of a particular legume and, from a practical standpoint, it will be necessary, in order to obtain the best results, to use specific cultures or sources of bacteria for specific crops.

But if these bacteria are absent, how are we to supply them? This is one of the most important items to be considered in the growing of leguminous crops. This process, known as soil inoculation, may be affected by applying the material containing the germs directly to the soil, or by bringing the seed in contact with the inoculating material before planting. Soil from a field where a leguminous plant has been recently and successfully grown, is a good inoculating material for the same plant, in a soil destitute or deficient in the required form of bacterial life.

At the Kansas Experiment Station it was found that soja beans would not bear tubercles. They then proceeded to inoculate the Kansas soil with inoculated soil from the Hatch Experiment Station at Amherst, Massachusetts. Of course, only a small area was inoculated at first, and from this more extensive inoculation took place. Two methods were used; first, the finely-pulverized, Massachusetts soil was placed directly in the hill; secondly, water was added to a certain quantity of soil placed in a suitable vessel. The soil was allowed to settle to the bottom, and the water was then drawn off and applied to the plants.

From this experiment it was determined that the best time to inoculate a soil is at the time of planting a crop, and that it is better to inoculate with soil directly than to use the extract. But both methods gave very satisfactory results. This practice was carried on, on a small scale, for several years, and then the soil thus inoculated, was used in a drill, as fertilizer, after being finely powdered, and applied at the rate of six hundred pounds per acre. This drilling method is an ideal way of inoculating the soil.

There is a prevailing belief that all leguminous plants increase the fertility of the soil, but there are a few species of this family that do not gather atmospheric nitrogen; therefore, they do not increase the fertility, except by the addition of humus, and by improving the mechanical condition of the soil, which may be said of most plants. It is safe to say that only those legumes increase the fertility of the soil which bear tubercles on the roots, and those plants which do not produce tubercles are not agricultural legumes, although they are properly classed as Leguminosae. Practically all of the wild Maryland species examined have tubercles on the roots, which goes to show that their specific germ, if any, is widely distributed in the soils, making inoculation in most cases unnecessary, unless with an improved strain of bacteria to increase the yield.

#### COMPARATIVE VALUE OF WILD AND CULTIVATED LEGUMINOUS PLANTS.

In considering the use of a leguminous crop on cultivated land one would naturally turn to such cultivated kinds as are already well known and adapted to our farms; for example, red clover, crimson clover, alfalfa, cow peas, vetch, etc. Some of the wild kinds, however, might prove as valuable under cultivation, at least when the better strains have been selected and improved.

But when we consider the large areas of uncultivated land in Maryland, where no crop is or will be grown under present conditions, the value of the wild legume in building up such land by adding humus and nitrogen becomes much more worthy of consideration, especially if we remember the fact that the most of our waste woodland and fields are covered with a natural growth of leguminous plants, doing their work without a particle of labor on the part of the owner. On many thousand acres of waste land over one-half of the weed growth is composed of nitrogen gathering leguminous plants. If by any means these



Fig. 3—Cow-pea—After Abel, Farmers' Bulletin 121, United States Department of Agriculture.

plants can be encouraged to grow on uncultivated land their value will be increased. The rank growing forms and those most rich in nitrogen or which seed themselves most rapidly could be introduced on places where they do not now occur, and might soon take the place of useless weeds. A great many of these species grow with the greatest ease on

dry, sandy or sterile land where other plants would not succeed until the legumes had opened the way. Some, like the partridge-pea, rabbit-clover, and hop-clover, often cover the stubble fields with a spontaneous growth in summer and thus add to their fertility.

#### OTHER USES.

Bush-clovers, the wild true clovers, beggar-ticks, etc., form the most valuable part of the wild pasture of the woodlands, and the occurrence of leguminous weeds in cultivated fields is not to be regretted as much as that of many other plants of less value to the soil. The seeds of many leguminous plants, for example, beans and peas, are good food materials; others contain valuable coloring matters and the bark of many is exceptionally rich in tannin; some are cultivated for ornament.

Other minor uses will be mentioned under the individual species in the list to follow.

#### FUTURE POSSIBILITIES.

Many things remain to be determined regarding the useful qualities of the wild leguminous plants. The herbage, roots and seed of the different kinds should be subjected to chemical analysis to determine their varied nitrogen content. They should be examined with reference to the presence of a greater or less amount of nodules on the roots. The most promising should be cultivated and improved from year to year by selection of the best for different purposes—hay, pasture, green manuring, seed, etc. Experiments along some of the more important of these lines are in progress at the Maryland Experiment Station. Several kinds are being grown and seed of the most promising kinds, like some of the beggar-ticks, bush-clovers, and partridge peas, have been planted.

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### MARYLAND LEGUMINOSAE.

Our wild leguminous plants are distinguished from other plants, first by their irregular flowers (usually with ten stamens) which more or less resemble those of the pea and bean, although they may be much smaller, and often clustered in heads, which may be mistaken for a single flower, as in the clover. Exceptions are the cassias, honey locust, and albizzia, which have regular flowers; the last two being trees and the cassias being recognized by the finely divided, pinnate leaves and flat bean-like pods.

A second characteristic of legumes is the compound leaves, with three or more leaflets, to each leaf, as in clover, or with many small leaflets arranged like the parts of a feather (pinnate) as in the partridge-pea (see Figure 9). Sometimes the leaf ends in a tendril (as the vetches) and in the lupine the leaves are arranged as in the clover but five or more leaflets together on the end of the leaf stalk. A peculiar swollen joint is seen at the base of each leaf or leaflet by which they

fold up at night, etc. Exceptions in leaf form are the red-bud tree, which has a large heart-shaped leaf, and the rattle-box with entire leaves having arrow-shaped wings on the stems below each.

As a third distinguishing mark, nearly all leguminous plants have more or less pea-like pods which, however, may be short and only one-seeded as in the case of clover or alfalfa.

#### DISTRIBUTION IN THE STATE.

The maps prepared from our notes and specimens show that while several species of Leguminosae are found in all parts of the State which

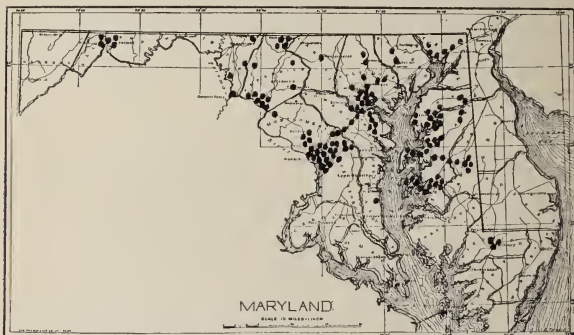


Fig. 4.—The dots show where introduced legumes have been found wild in Maryland.

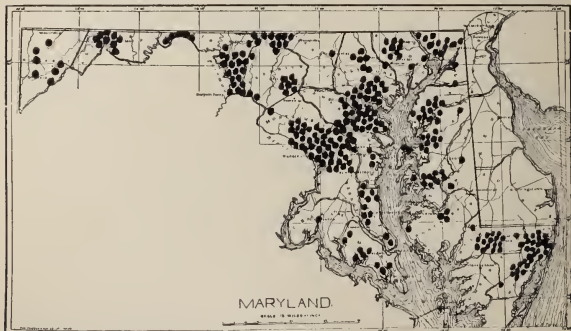


Fig. 5.—The dots show where native legumes have been found in Maryland.

have been examined, many more of both species and individuals occur in the sandy lands of Prince George and Anne Arundel Counties, and the southeast and central parts of the Peninsula than elsewhere. Very few species are abundant in wet lands; consequently marshy regions, like those of Dorchester and Somerset Counties, are not abundantly

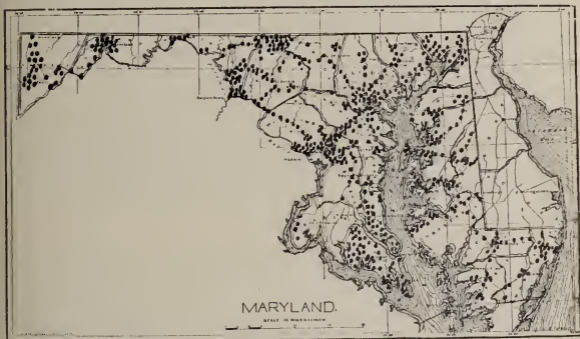


Fig. 6—The dots show parts of Maryland which have been explored botanically.

provided with them; the salt water is destructive to most legumes, especially some of the clovers. Neither do the mountainous sections

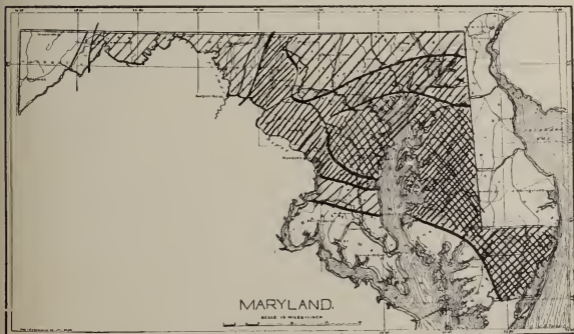


Fig. 7—Showing the proportion of leguminous plants in different parts of Maryland to the whole number of plants observed. The heavier shading denotes the greater abundance of legumes. This is based on our notes and collections from various parts of the State, which are not sufficient for more than a rough approximation.

with rich soil seem so favorable to their growth, although these parts of the State have their particular species which do well, and legumes of some kind are found in every climate and soil. In many parts of Maryland legumes form from one-quarter to three-quarters of the wild plants. Nearly all our clovers and related plants and several other leguminous species are natives of Europe and have been introduced by man, and run wild here. Figure 4 shows that most of these occur, as would be expected, in the parts of the State where there is most traffic. It must be borne in mind that several parts of the State (see Figure 6) have not been explored and this must be considered in interpreting these maps.

#### HOW TO FIND OUT THE NAMES.

If one is interested in the wild legumes growing on his farm and is not familiar with the different kinds, fresh leaves, with flowers and pods, if possible, can be put in an envelope or wrapped in paper and mailed to the Experiment Station, at College Park, where the names will be supplied for him.

The following comparison of characteristics and easily-observed peculiarities of the different species has been devised as a key by which any one unfamiliar with the plants may, with any one of our wild legumes in hand, determine for himself the proper name for it. The figures (Plate I.) of the leaves, etc., will also be helpful. After looking up the plant in the key consult the catalogue of species for a more complete description.



Fig. 8—Nodules on roots of alfalfa.



Fig. 9—Partridge-pea.

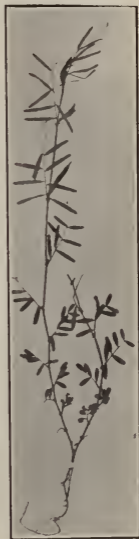


Fig. 10—Wild Vetch  
(*Vicia angustifolia*)

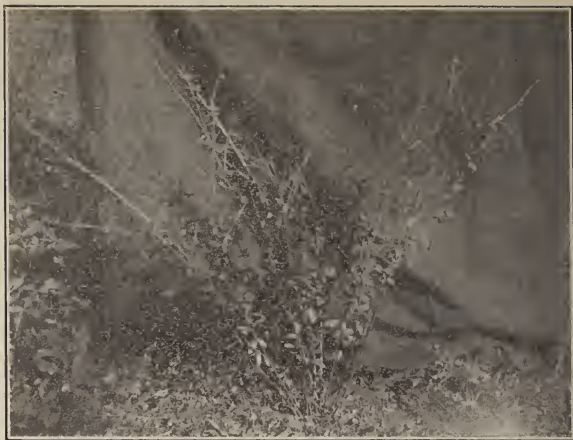


Fig. 11— Beggar-tick (*Mibomia Marylandica*).



Fig. 12—Bush-clover (*Lespedeza repens*) covering the ground; a beggar-tick in upper left hand corner.

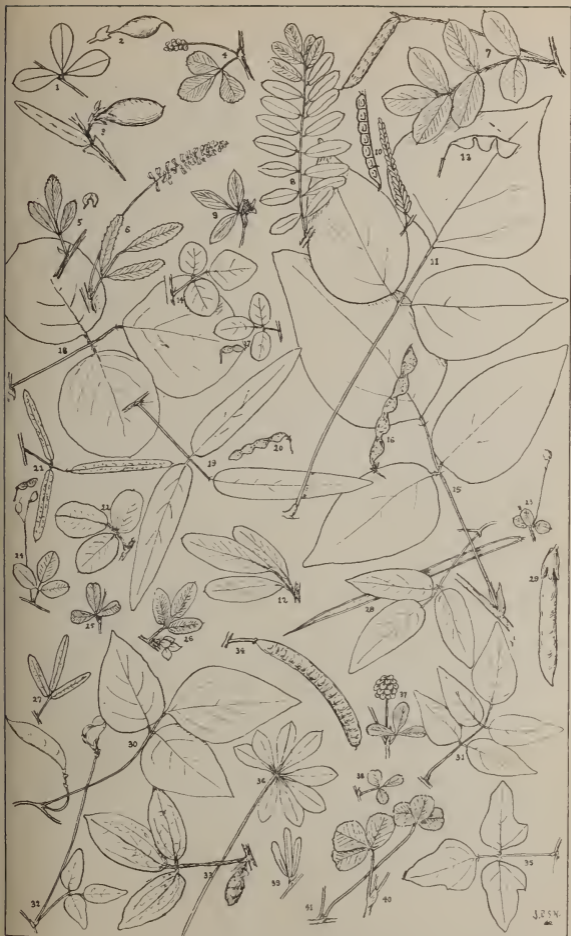


Plate 1—Leaves and pods of legumes.

## EXPLANATION OF PLATE I.

The figures are all one-half natural size and are nearly all drawn from herbarium specimens of Maryland plants.

- Figure 1. Leaf of wild indigo.  
" 2. Pod of same.  
" 3. Leaf and pod of rattle-box.  
" 4. Leaf and cluster of pods of black medic.  
" 5. Leaf and pod of alfalfa.  
" 6. Leaf and flower cluster of sweet clover.  
" 7. Leaf and pod of cracca.  
" 8. Leaf of cat-gut.  
" 9. Leaf and pod of pencil flower.  
" 10. Pod and partly folded leaf of joint vetch.  
" 11. Leaf of beggar-tick (*Meibomia grandiflora*).  
" 12. Leaf of bush-clover (*Lespedeza capitata*).  
" 13. Pod of beggar-tick (*Meibomia grandiflora*).  
" 14. Small leaf of beggar-tick (*Meibomia arenicola*).  
" 15. Leaf of beggar-tick (*Meibomia canescens*).  
" 16. Pod of same.  
" 17. Leaf and pod of beggar-tick (*Meibomia obtusa*).  
" 18. Leaf of beggar-tick (*Meibomia Michauxii*).  
" 19. Leaf of beggar-tick (*Meibomia paniculata*).  
" 20. Pod of same.  
" 21. Pod and leaf of beggar-tick (*Meibomia stricta*).  
" 22. Leaf of bush-clover (*Lespedeza hirta*).  
" 23. Pod and small leaf of bush-clover (*Lespedeza procumbens*).  
" 24. Leaf and two pods of bush-clover (*Lespedeza repens*).  
" 25. Leaf of Japan clover.  
" 26. Leaf and cluster of pods of bush-clover (*Lespedeza Stuevei*).  
" 27. Leaf of bush-clover (*Lespedeza Virginica*).  
" 28. Leaf and pod of butterfly-pea (*Bradburya*).  
" 29. Pod of butterfly-pea (*Clitoria*).  
" 30. Leaf and pod of hog peanut (*Falcata comosa*).  
" 31. Leaf of ground-nut.  
" 32. Small leaf and flower of wild bean (*Strophostyles umbellata*).  
" 33. Leaf and pod of *Dolicholus*.  
" 34. Pod of wild senna.  
" 35. Leaf of wild bean (*Strophostyles helvola*).  
" 36. Leaf of lupine.  
" 37. Leaf and head of yellow clover.  
" 38. Leaf of hop-clover.  
" 39. Leaf of rabbit clover.  
" 40. Leaf of alsike clover.  
" 41. Leaf of white clover.

## KEY.

The different kinds of leguminous plants of Maryland, may for ease in finding the names, be divided into the following classes: A, Trees; B, Climbing or trailing vines; C, Erect or spreading herbs.

A. The three trees may be distinguished as follows: 1. Leaves large and heart-shaped, the pink flowers appearing in the spring before the leaves—*red-bud*. 2. Leaves with 9 to 20 leaflets, 2 spines at the base of each leaf—*black locust*. 3. Leaves with many small leaflets, usually many large thorns on the body of the tree—*honey locust*. *Albizzia*, usually seen in cultivation, has many very small leaflets and no thorns.

B. If the vine is woody it is *wistaria*. If not, and each leaf has several leaflets, the vine is one of the following three: A tendril at the apex of the leaf indicating that it is one of the 7 kinds of (1) *vetches* that we have, or one of our two species of (2) *lathyrus*; if there are no tendrils it is the (3) *ground-nut*.

Several of the vines have only three leaflets to each leaf. If the pods of these are composed of more or less triangular, flat, adhesive joints, it is a *beggar-tick*. If the pod is small, flat, and one-seeded, it is a *bush-clover*. If the pods of the vine are bean or pea-like, it is one of the following: *Butterfly pea* (with large purple flowers), one of the *hog peanuts*, the *milk pea* or one of the three *wild beans*.

*Black medic* and some of the *clovers* are sometimes vine-like.

C. If the herb at hand has only one leaflet to each leaf it is *rattle-bor*.

If each leaf has three leaflets, and the pods are several seeded, it is one of the two *indigos* (with inflated pods), one of the many *beggar-ticks* (with flat, jointed, adhesive pods), *butterfly pea* (with large purplish flowers) or the *milk pea*.

If each leaf has three leaflets and the pods are only one-seeded, it is one of the two *sweet clovers* (with small, yellow or white flowers in loose spikes), *alfalfa*, *black medic*, one of the *clovers* (with small flowers in heads) one of the many *bush-clovers*, (with flat, one-seeded pods), *Japan clover* or *pencil flower*.

If there are several leaflets radiating from the end of the leaf stalk it is *lupine*.

If the leaves are pinnate with several leaflets and have yellow or orange-colored flowers the plant is one of the *partridge peas*, *wild senna* or *joint vetch*. If the flowers are some other color the plant may be *cracca*, *milk vetch* or *crown vetch*.

After comparing the plants with the above key look them up in the following catalogue of species where the plants named in the key will be found further described.

Sixty-eight species of this family have been found wild in this State and several others probably occur rarely. Each of these is taken up in the following pages, and its distribution in the State, abundance,

habitat, uses, and possibilities discussed. The most important kinds are mentioned first in the list. The most commonly used name, so far as can be determined, is given for each plant, followed by the scientific name.

#### CATALOGUE OF SPECIES.

*The Clovers, Trifolium.* The members of this genus found wild in Maryland are nearly all natives of the Eastern Hemisphere and introduced by man into America, where they have run wild. Some are well-known cultivated plants, but frequently occur wild also. All are



Fig. 13—Alsike Clover—After cut in Bulletin of United States Department of Agriculture.

recognized by the trifoliate leaves, the margins of which are finely toothed, and the small flowers in close heads, bearing straight, unflattened, one-seeded pods. The following clovers are wild in Maryland:

*Yellow clover, Trifolium aureum.* Usually about twelve inches high, the flowers yellow; the central one of the three leaflets not stalked. Introduced into fields and waste places in Northeastern United States, but not extending as far south as extreme Southern Maryland. Often so abundant in Central Maryland as to form over half of the vegetation of some old fields, and is considered of some pasture value on sandy land. (Plate I. Figure 27).

*Rabbit-foot clover, Trifolium arvense.* Also called *pussy clover, rabbit clover*, etc. A narrow-leaved, annual clover, one foot high, with soft, silky, cylindrical heads of whitish flowers. Introduced in fields and waste places over the Eastern and Southern States. Common over Maryland, especially in somewhat sandy fields where it often forms the principal growth after harvest. Earlier in fields of low crops, like strawberries, where it is much in the way. It might be utilized as an early mulch, as it matures so much sooner than other clovers. (Plate I. Figure 39).

*Hop clover, Trifolium dubium.* This small clover may occur rarely in Maryland but has not been found yet. It is from Europe and may be recognized by the heads containing less than twelve small, yellow flowers.

*Alsike clover, Trifolium hybridum.* A perennial clover, fifteen inches high, resembling the common white clover, but is more erect and pink-flowered. It is native in Europe and occurs wild frequently in the Northern United States. It may frequently be seen wild in fields in Central Maryland, usually among other clovers. Does best in moist land. The flowers furnish honey for bees. (Figure 13 and Plate I. Figure 40).

*Crimson clover, Trifolium incarnatum.* This well-known cultivated annual clover, one to three feet high, with cylindrical heads of crimson flowers, is sometimes seen wild around fields in Maryland and other parts of the Northeast United States.

*Red clover, Trifolium pratense.* This most common cultivated clover is often found growing wild in fertile fields and meadows of Maryland and other parts of the United States. It is not common wild in our western counties and is not recorded wild from the southern counties on either side of the bay.

*Hop clover, Trifolium procumbens.* This species of low, spreading hop clover has heads of twenty to forty yellow flowers and has the central leaflet of each leaf projected beyond the other two by a little stalk. It is found naturalized frequently in all parts of Maryland and states north and south in fields and along roadsides, where it may be of some value as early summer pasture. (Plate I. Figure 38).

*Buffalo clover, Trifolium reflexum,* is somewhat like alsike clover, but the heads over one inch in diameter and borne on a much shorter stalk above the leaves. It is a native of meadows in many parts of the Eastern United States and may occur in Maryland.

*White clover, Trifolium repens.* The common creeping clover of our lawns and meadows, with small heads of white flowers on slender stalks, six inches or less long, arising from the creeping stems. Native in Europe and Northern United States and common wild in moist places in Central Maryland as well as other parts of the State. It is an excellent honey plant and is often used in lawns and meadows. (Plate I. Figure 41).

*Black medic, Medicago lupulina.* A low, clover-like, annual plant, but with yellow flowers and the small, one-seeded pods curved or coiled. Introduced from the Old World where it is well thought of as a forage

plant, but native now in all temperate regions. Common in fields in Central Maryland and seen on the Eastern Shore near Easton and Centreville. It is said to be a good pasture plant on wet meadows or stiff clay soils, too poor to grow clover or alfalfa. It stands drouth well. (Plate I. Figure 4).

*Alfalfa, Medicago sativa.* Wild plants of this well-known agricultural crop have been seen in Maryland at Washington Junction, and

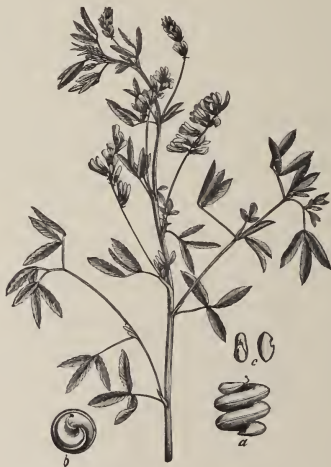


Fig. 14—Alfalfa, or Lucerne (*Medicago sativa*); a, b, seed pod, side and end view; c, seeds enlarged. After Smith, Farmers' Bulletin 66, United States Department of Agriculture.

in District of Columbia. The flowers are rich in honey and the great feeding value is well known. (Figure 14 and Plate I. Figure 5).

*Partridge pea, Cassia Chamacrista.* A low, branching, annual herb, one-half to three feet high, with pinnate leaves of about twenty small leaflets each and large yellow flowers which are more regular in shape than in most leguminous plants. Common in the dryer soils in fields east of the mountains of Maryland, especially on the Eastern Shore, and found all over the Eastern States. One of the most promising wild plants for nitrogenous green manuring. Often covers, naturally, the stubble fields with a dense growth. Cultivated occasionally, since very early times in Virginia, for improving land. (Figure 9).

*Sensitive pea, Cassia nictitans,* is like the last, but smaller and with finer leaves and much smaller flowers; the pods assume a more erect

position than in the partridge pea. Occurs in the same area but not so abundantly, and is a lover of wet, sandy land.

*Wild senna, Cassia Marylandica*, is an erect, little-branched, perennial herb, three feet high; with large, pinnate leaves and short spikes of yellow flowers. It occurs in rather moist soil, usually along roadsides and edges of fields in Western Maryland, but is not common. It is found in all the Eastern and Southern States. The foilage is sometimes used in medicine in place of the Old World senna. (Plate I. Figure 34).

*Bush-clovers, Lespedeza*. There are ten species of *Lespedeza* found in the State. They resemble some of the more slender clovers, having wiry stems with trifoliate leaves, the middle leaflets with a short stalk. The pods are small, flat and one-seeded. They form the great body of the wild leguminous covering of the ground in woods and old fields, are eaten by cattle and sheep, especially when young, and do a great deal in building up waste land.

*Lespedeza capitata*, is a yellow-flowered perennial, about three feet high, with leaflets twice as long as broad. In dry fields or open, sandy woods over the Eastern States. Not seen on Eastern Shore, but occasionally in Western Maryland. It is a good pasture plant. (Plate I. Figure 12).

*Lespedeza frutescens*. An erect perennial, two feet high, with oval leaflets and clusters of purplish flowers at the top. In dry soil over the Eastern United States. Frequent in Western Maryland but not so common in sandy lands as in the dry upland woods.

*Lespedeza hirta*. A tall, hairy perennial, three feet high, with oval leaflets and clusters of small, yellowish flowers above. In dry, mostly rocky loam in Eastern States. This is one of the most common legumes in the mountainous and highland counties of Maryland, but is infrequent on the Eastern Shore or in Southern Maryland. (Plate I. Figure 22).

*Lespedeza Nuttallii* is much like *Lespedeza frutescens* but the flower clusters are longer stalked. It is found in dry soil in most of the Eastern United States. In Maryland one specimen has been seen from Baltimore County and one from Anne Arundel.

*Lespedeza procumbens* is a trailing perennial, with hairy, oval leaves and very open clusters of purplish flowers. Found mostly in dry woods in the states east of the Mississippi. It has been seen in many places in Central Maryland in dry, or especially sandy, woods and in the Atlantic coast counties. It is of some value in wild pastures. (Plate I. Figure 23).

*Lespedeza repens* is similar to the last, but the leaves are smooth. It is common in open, dry, sandy woods and old fields all over Maryland, and from New Jersey to Texas. It often covers the ground in woods (Figure 12 and Plate I. Figure 24).

*Japan clover, Lespedeza striata*, differs from the other *Lespedezas*, it being an annual, about ten inches high. It has small, yellow flowers, not in clusters, and the leaflets blunt at the apex and tapering to the

base. It is a native of East Asia, but now grows wild in all the Southern States, where it is esteemed as an agricultural plant, and has been seen wild in Baltimore, Carroll, Montgomery, Prince George and Cal-



Fig. 15—Japan Clover (*Lespedeza striata*). After Tracy, Bulletin 15, Division of Agrostology, United States Department of Agriculture.

vert Counties and in District of Columbia. It is said to do well on soils deficient in lime, but not in dry, sandy land. (Figure 15 and Plate I. Figure 25).

*Lespedeza Sturtei* is much like *Lespedeza frutescens* but the leaves and stems are hairy. It is found in dry soil usually in open woods in the Northeastern United States. The only Maryland specimens we have seen are from Easton and Salisbury. (Plate I. Figure 26).

*Lespedeza violacea* is much like *Lespedeza repens* but erect, two feet high. It is found in dry soil in all the eastern half of the United States. It has been seen but rarely in Maryland near the District of Columbia, and is doubtfully reported from Cumberland.

*Lespedeza Virginica* is an erect perennial, one foot high, with very narrow leaflets and clusters of purplish flowers along the stem and at the top. It is found in dry soil over all the Eastern United States. This is one of the most common bush-clovers east of the mountains in Maryland in dry woods, especially in sandy places, and along roadside banks. It has not been seen, however, in the two western counties. It is one of the best early pasture plants in woods, etc., and a great soil improver; worthy of trial in cultivation. (Plate I. Figure 27).

*Beggar-ticks, Meibomia.* This genus is also known to botanists as *Desmodium* and locally by the common names of *tick-trefoil*, *beggar-weed* and *beggar-lice*, on account of the adhesive joints of the pods, which are more or less triangular in shape, flat and easily separated from one another. The leaves are usually comparatively large and each with three leaflets. The bush clovers are all perennial herbs, usually tall-growing, the flowers usually purplish like *Lespedeza*, but the more than one-seeded pods distinguish them. Some of them are worthy of trial in cultivation. Several are good forage, especially the woodland forms. The genus is well represented in Maryland by the following species:

*Meibomia arenicola* is a trailing plant of dry woods in the Southern States, with small, nearly round, almost smooth leaflets; seen only once in extreme Southern Maryland. (Plate I. Figure 14).

*Meibomia bracteosa*, four feet tall, with broad, long-pointed leaflets, probably occurs in Maryland near District of Columbia, but is seen most commonly in states west of this.

*Meibomia canescens* is four feet high, with rough, hairy, pale-green, broad, blunt-pointed leaflets. It is common over the eastern half of the United States and is one of the commonest large beggar-ticks of rich soil in Maryland from Frederick to Centreville and Baltimore to Washington, but none have been collected in the State outside this region. (Plate I. Figures 15 and 16).

*Meibomia Dillenii* is a lower, smoother plant than the last, and the somewhat hairy, thin, oval, green, blunt-pointed leaflets twice as long as broad. Common in woods and old fields north and west of Maryland and in most of our counties west of the bay.

*Meibomia glabella* has a long trailing stem, sometimes eight feet long, dull-green, oval leaflets and purplish flowers. It is found in dry, sandy woods along the Atlantic coast, and occurs in Maryland at Salisbury.

*Meibomia grandiflora* is about two or three feet high, the large leaves with round, short-pointed leaflets clustered at the base of the slender, branched flower stem. This plant occurs in dry or rocky woods in the eastern half of the United States, mostly northward. It has been seen rarely in Maryland and District of Columbia. We have a specimen from Berlin and it is reported from Cumberland. (Plate I. Figures 11 and 14).

*Meibomia laevigata.* A plant about three feet high with the leaflets oval, blunt-pointed, about twice as long as broad, and perfectly smooth. Found in dry woods along the Atlantic coast of the United States. In Maryland it has been seen near Baltimore and Washington and at Easton and Snow Hill.

*Meibomia Marylandica.* A plant two to three feet high with small, elliptical leaflets with only a few minute hairs on them. The joints of the pod only two or three, most of the other species mentioned having more than three. In old fields in the Eastern United States. A com-

mon legume in our waste fields in Maryland, especially in the central part of the State. Berlin is the only place we have seen it on the Eastern Shore, but it is no doubt common elsewhere. (Figure 11).

*Meibomia Michauxii*. Prostrate and almost vine-like, two to six feet long, with large, round, hairy leaflets. In dry, rich, usually rocky, woods over the Eastern United States. In Maryland found only in the central counties, in mountainous or at least stony situations. (Plate I. Figure 18).

*Meibomia nudiflora* is much like *Meibomia grandiflora*, but the leaves and flowers are on separate stems arising from the same root. Common in dry woods in the eastern part of the United States and in all parts of Maryland.

*Meibomia obtusa* is very much like *Meibomia Marylandica*, but the stem and leaves are much more hairy. It is found in dry soil in the eastern part of the United States. It is not uncommon in Southern Maryland and perhaps occurs in other parts of the State. (Plate I. Figure 17).

*Meibomia ochroleuca* differs from *Meibomia glabella* in having larger, more-pointed, yellowish-green leaves and whitish flowers, the stems one to three feet long. It is found in woodlands from New Jersey to Georgia. The only plants we have seen from Maryland are from Easton and "Public Landing" on Eastern Shore. It is also reported from District of Columbia.

*Meibomia paniculata* is a very bushy plant about three feet high with narrow, perfectly smooth leaflets, several times as long as broad. In dry soil over the eastern half of the United States. This is the most common beggar-tick in Maryland, occurring all over the State in old fields and waste places or in open woods. (Plate I. Figures 19 and 20).

*Meibomia pauciflora* resembles *Meibomia grandiflora* but the leaves are scattered more along the stem and more narrowly oval in shape. In these two and *Meibomia nudiflora* the pointed pods are only constricted on one side, in the other beggar-ticks they are more or less constricted on both sides. In woods in the Eastern United States. Seen in Maryland, in Washington, Frederick and Worcester counties, also in District of Columbia.

*Meibomia rigida*. Like *Meibomia Marylandica*, this plant has only two or three joints to the pod, but differs in having the leaflets rough, more elongated and over an inch long. It is found in dry soil in the eastern half of the United States. We have only two plants of this from Maryland, one from Calvert County and one from Berlin.

*Meibomia stricta* has very narrow leaflets and only one to three-jointed pods. It is found in open pine woods and from New Jersey southward along the coast. It has been found in Maryland, at Salisbury and Ocean City. (Plate I. Figure 21).

*Meibomia viridiflora* is a rather large plant with broadly oval, somewhat pointed leaflets, which are silky-hairy on the underside. It

is found in dry woods in the Eastern United States as far north as Pennsylvania. In Maryland it has been seen at Bel Air, Prince Fredericktown and Salisbury.

*White sweet clover, Melilotus alba*, also known as *white melilot*, *sweet-scented clover*, *bee clover*, and *Bokhara clover*. A vigorous growing annual or biennial, three to ten feet high, differing from the true clovers in having the small white flowers in slender, open spikes instead of close heads. The foliage is fragrant in drying. This is a native of the Old World, but introduced and growing wild in various parts of the United States, especially around towns. It grows in all kinds of waste places, even on quite sterile ground, especially if rich in lime. It is very common in Maryland in counties bordering the northern part of Chesapeake Bay and east of the Blue Ridge. It is not common in the southern or extreme western counties of the State, especially away from the lines of traffic. It contains in the dry matter about seventeen or more per cent. of protein as compared with thirteen and sixteen per cent. respectively in red clover and white clover. The scent of the foliage makes it disagreeable to stock, but when used to it they eat it readily. The long roots bring up salts from the lower subsoil and it is good for green manuring. (Plate I. Figure 6).

*Yellow sweet clover, Melilotus officinalis*, is a smaller plant than the white sweet clover and has yellow flowers. It is also introduced from the Old World in many parts of our country, and is seen frequently in waste and wetter lands than the last around Baltimore and Washington. In Switzerland a powder from the dried leaves is used in flavoring chapziger cheese.

*Wild bean, Phaseolus polystachys*, is a high climbing vine, resembling very much in leaves, flowers and pods the cultivated bean vines; the flowers scattered along the flower stalk. It is an uncommon plant in moist or rocky thickets, especially along streams in the Eastern United States. We have seen Maryland specimens from Ellicott City, and along the Potomac, in Montgomery County. It is said to be greedily eaten by cattle.

*Wild bean, Strophostyles helvola*, is a prostrate or low climbing vine, two to eight feet long, which with the next one differs from *Phaseolus polystachys* in having the flowers clustered at the end of the flower stalk. At least some of the leaflets are more or less indented on the sides, often so much as to make the leaflets three-lobed. There are several varieties. It grows in sandy soil in Eastern United States from Massachusetts south especially along streams. In Maryland found over most of the Eastern Shore and occasionally west of the Bay. It approaches the cowpea in feeding value, and has great promise. (Figure 16 and Plate I. Figure 35).

*Wild bean, Strophostyles umbellata*, is a smaller trailing vine, one to five feet long, perennial and the margin of the narrower leaves entire. In sandy soil, mostly in the Atlantic coast states. Very common in old fields and in sand, in Maryland east of Frederick County.

and south of Baltimore. It is no doubt useful in pastures, and is worthy of encouragement in fields. (Plate I. Figure 32).



Fig. 16—Wild Bean (*Strophostyles helvola*). After Bentley, Bulletin 10, Division of Agrostology, United States Department of Agriculture.

The following *Wild Vetches* occur in this region:

*Vicia angustifolia* is an annual vine about eighteen inches long with pinnate leaves ending in a tendril as do the other vetches, narrow leaflets and with one or two purple flowers close in the axils of the leaves. Naturalized from Europe in the Atlantic coast states and occurring frequently in old fields in many parts of Maryland. Most of the vetches are good for forage. (Figure 10).

*Vicia Americana*. A perennial vine two to three feet long; the bluish flowers about three-quarters of an inch long and about seven in each cluster. Occurs in moist ground in the northern states and probably occasionally in Maryland.

*Vicia Caroliniana* differs from the last in the white flowers, less than half an inch long and about twelve in each cluster. It is found along river banks mostly west and south of this, and is seen rarely along the Potomac above Washington.

*Vicia Cracca*, a perennial with dense, one-sided spikes of purplish flowers, found in the Northern States and Europe in dry soil. May be seen rarely in Maryland.

*Tare*, *Vicia hirsuta*, somewhat like the last, but annual, few flowered and hairy, may occur rarely in Maryland. It is a native of Europe.

*Vicia tetrasperma*, like the last, but smooth, may also occur in Maryland. Also from Europe and sparingly introduced in the Northern States; found in District of Columbia.

*Hairy vetch*, *Vicia villosa*, a cultivated annual vetch with long spikes of purplish flowers like *Vicia Cracca*, but quite hairy, sometimes grows spontaneously around fields where it has been cultivated. (Figure 17).



Fig. 17—Hairy Vetch (*Vicia villosa*). After Tracy, Bulletin 15, Division of Agrostology, United States Department of Agriculture.

*Wild pea*, *Lathyrus venosus*. A short perennial vine with pinnate leaves ending in a tendril and pea-like pods and flowers, growing on moist banks north and west of Maryland is rare here along the Potomac. It is very valuable in wild pastures.

*Hog-peanut, Falcata comosa.* A slender, climbing vine with trifoliate, bean-like leaves and thin, flat pods with small seeds above, but much larger seeds borne underground on the lower branches. In moist open woods, especially on the rocky banks of streams; common west of the Bay, and in most of the Eastern States, not common on the Eastern Shore. It adds some to woodland pastures, the underground seeds being eaten by hogs and the vines by other stock. (Plate I. Figure 30).

*Hog-peanut, Falcata Pitcheri.* Similar to the other hog-peanut but larger and rougher; the vine covered with stiff hairs. Common west and north. One specimen found at Greenmount, Maryland.

*Ground-nut, Apios tuberosa.* A climbing vine with large clusters of large, handsome, brownish, fragrant flowers and tuberous roots, found in moist ground in old fields and edges of woods all over the Eastern United States. It is seen frequently in the counties of Maryland bordering the Bay and in a few other places. The fleshy roots were used for food by the Indians and others. The vine is valuable for ornamental purposes; it is eaten by stock and the tubers by hogs. (Plate I. Figure 31).

*Butterfly-pea, Bradburya Virginiana.* A perennial vine with trifoliate leaves and very large purplish flowers. Found frequently in the sandy lands of the lower part of the Peninsula in Maryland and more commonly in the South. Very ornamental, and adds to wild pasture. (Plate I. Figure 28).

*Butterfly-pea Clitoria Mariana.* A vine-like herb, one to three feet high, differing from Bradburya mainly in less twining stem and shorter pods not thickened at the edges. In dry soil in the Southern States and north to New Jersey and extending inland in Maryland to Frederick County. It is said to be nutritious to stock. (Plate I. Figure 29).

*Black locust, Robinia Pseudacacia,* is a well known tree with a maximum height of eighty feet, with pinnate leaves, a pair of stout spines at the base of each, and having clusters of large, white, fragrant flowers. It is a native of the Mississippi Valley, but extensively naturalized along our fence-rows and in waste lands, often in quite moist places, but then not bearing tubercles so abundantly. Found especially in Central Maryland, but is not so common in the southern part of the Eastern Shore. The wood is strong and durable, and is commonly used for posts, but also for finer woodwork. Perfume has been made from the very fragrant flowers, which are also rich in honey.

*Honey locust, Gleditsia triacanthos.* A large tree with much divided leaves, and long, flat pods; usually with branched thorns, but often thornless. Native of the Eastern Mississippi Valley, but naturalized in many places in cultivated lands in Maryland and other States eastward. The hard wood is of value. The pulp of the pods is sweet when fresh, hence the name. The thornless kind is best for ornament. Stock eat the pods and young growth.

*Red bud, Cercis Canadensis.* A small tree with large, heart-shaped leaves and clusters of pink flowers appearing along the branches before the leaves in the spring. Usually seen on rocky, rich hillsides throughout Western Maryland and the Eastern States generally, occasionally on the Eastern Shore, but is not a common tree. The hard, finely-colored wood is of some value for working, and has been used as dye-wood. The sweet-tasting flower buds have been used in salads.

*Wild lupine, Lupinus perennis.* A low perennial with long spikes of large blue flowers rising above the plant and producing flat, hairy bean-like pods. The leaves are peculiar in having about eight wedge-shaped leaflets radiating from the end of each leaf stalk. In very dry, sandy soil in all the Eastern United States, but unlike many legumes does not do well in calcarious soils. In Maryland it has been seen in several places between Washington and Baltimore and in northern Baltimore County, but it is not common. The seeds are said to be poisonous. (Plate I. Figure 36).

*Rattle-box Crotalaria sagittalis.* A small annual herb about four to eight inches high, with entire leaves, the stem having a pointed wing below each leaf; flowers yellow; pod inflated, so that seed rattle in it when dry. Frequent in dry clay or sandy upland, all over the Eastern and Southern States. Poisonous to stock, and causing serious disease in horses when eaten by them. (Plate I. Figure 3).

*Dolicholus, Dolicholus erectus.* A perennial herb, erect and stout, about one foot high, with leaves of three leaflets, velvety and heavily veined; clusters of yellow flowers and short few-seeded pods. Sandy land, Southern Maryland, and southern part of Eastern Shore and States southward; not common. (Plate I. Figure 33).

*Milk-pea, Galactia volubilis.* A slender, smooth, climbing vine, with trifoliate leaves, rounded at the apex, and bean-like pods. In dry soil over the Eastern United States. not common in Maryland.

*Crown vetch, Coronilla varia.* A vetch-like perennial, one to two feet high, with pinnate leaves and clusters of whitish flowers in long-stalked heads. Occasionally seen around Baltimore and in States northward; introduced from Europe.

*Joint vetch, Aeschynomene Virginica.* An annual, three feet high, with leaves resembling those of the partridge-pea, and jointed pods. Grows along river banks in the Eastern and Southern States near the coast; seen only occasionally in Maryland. (Plate I. Figure 10).

*Milk vetch, Astragalus Carolinianus.* A perennial herb about three feet tall, with pinnate leaves and spikes of white flowers. Common along streams west, but rare in Maryland, along the Potomac. Cattle are said to be fond of it.

*False indigo, Baptisia australis.* A small slightly-branched perennial herb with spikes of large blue flowers. Very rare in Maryland, along the Potomac and possibly elsewhere in rich soil, but common west of us.

*Wild indigo, Baptisia tinctoria.* A much-branched perennial herb with trifoliate leaves and medium size yellow flowers. Very common in dry woods of Eastern Maryland, and in adjoining States. The herbage, rich in blue dye stuff, was formerly used for making indigo; the young shoots have been used as asparagus, and the plant is now sometimes utilized by teamsters in the country for keeping flies from the horses's heads. (Plate I. Figures 1 and 2).

*Cracca, Cracca spicata.* A small, straggling perennial herb with pinnate leaves and covered with brown hairs; the few flowers purplish. This is a plant of the Southern States, seen rarely on Eastern Shore. (Plate I. Figure 7).

*Cat-gut Cracca Virginiana.* A stiff, somewhat shrub-like perennial plant, one to two feet high, with grayish, pinnate leaves and a cluster of yellowish-purple flowers. One of the most common plants in our dry upland woods, especially in sandy lands and occurs all over the Eastern United States; probably not so common on the Eastern Shore, as it is not represented in our collections from that section. (Plate I. Figure 8).

*Pencil-flower, stylosanthes biflora.* A low, wiry-stemmed plant resembling Japan clover but with yellow bristles on the foliage which surrounds the flowers. Eastern United States south of New York, in dry soil. Frequent in the dry, open woods of Central and Southern Maryland, not seen on the Eastern Shore nor in the mountains. (Plate I. Figure 9).

*American wistaria, Bradleya frutescens.* A large woody vine with clusters of large purple flowers. Low ground in the Southern States, reported from Cumberland, Md.

*Albizzia Julibrissan.* A tropical tree, sometimes called *mimosa* here, which is grown in Southern Maryland for ornament and occasionally seeds itself in warm, sandy Eastern Shore lands. The wood is useful and the aromatic leaves have been used for tea.

The following legumes have not been found in Maryland but occur in adjoining states: *Trifolium Carolinianum*, *Meibomia Canadensis*, *Lеспедеза angustifolia*, *Lathyrus myrtifolius*, *Galactia regularis*, *Ulex Europeans*, *Cytisus scoparius*.

# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

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BULLETIN No. 101.

APRIL, 1905.

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## THE COMMON INJURIOUS AND BENEFICIAL INSECTS OF MARYLAND.

### THE ENTOMOLOGICAL EXHIBIT OF THE MARYLAND EXPERIMENT STATION.

BY T. B. SYMONS.

#### INTRODUCTION.

With the hope of disseminating information in the most practical manner, the Director of the Experiment Station inaugurated the plan of making exhibits from the various Departments of the Station at the County Fairs, meetings of Agricultural Societies, and various other farmers' organizations. By his direction the following Entomological exhibit was prepared by Mr. A. B. Gahan, Assistant Entomologist under the supervision of the Entomologist. While the exhibit does not contain all the injurious insects affecting the more common agricultural and horticultural crops and is far from being complete, yet the aim has been to show the more injurious forms occurring in this State, giving a brief mention of the best known remedies for their control. The writer does not claim any originality for the contents of this bulletin as it is for the most part a compilation of the work of others.

It is thought that by showing the insects and their work, together with the remedies, that those persons who are not already familiar with the various insects can secure enough information for identification and proper treatment of the pest immediately, which is oftentimes necessary in saving a crop.

In addition to the thirty regular (16x19) cases of injurious insects, classified according to the different crops they attack, the pests of the household and miscellaneous insects, etc., there is shown several large "Riker mounts," containing miscellaneous Lepidoptera. While these have no direct economic importance, they do show the exquisite colors of some moths and butterflies, and serve to awaken in many people an interest and appreciation of the importance of insect life. There is also included in the exhibit a case showing some of our beneficial insects, which assist so greatly in the suppression of some of the injurious forms. It is particularly desirable that the farmer have sufficient

knowledge of the insect world to enable him to distinguish between the injurious and beneficial insects. It is hoped at some future time to publish a more complete account of the beneficial insects.

## ORCHARD FRUITS.

### INSECTS AFFECTING THE APPLE.

#### INJURING THE ROOTS.

#### THE WOOLLY APHIS.

#### *Schizoneura lanigera* Hausm.

Description: This pest is an exceedingly common one in the orchards of Maryland. The presence of the aerial form of the woolly aphis is readily detected by the bluish-white cottony or downy substance that is excreted by and covers the greater part of each wingless individual; and since these insects live in colonies, the patches of white matter are very conspicuous and can scarcely escape notice. The presence of the aphis under ground is readily detected by removing the earth from the roots near the trunk of the tree.

Life History: The insect winters in the egg or larva stage in Maryland. In mild winters they may often be found on the roots of

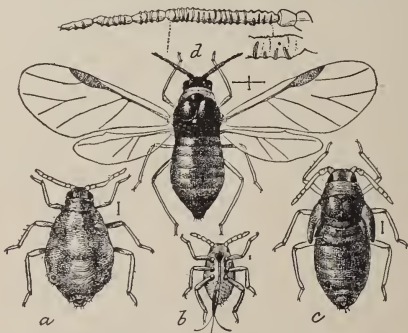


Fig. 1—The woolly aphis of the apple; a, agamic female; b, larva; c, winged female.

infested trees in a rather dormant state. There are several generations during the year. Figure 1 shows a winged and wingless female.

Nature of Injury: The insect causes injury in two forms. One form attacks the trunk and branches of the apple tree while the other

lives in the ground on the roots. On the roots they produce wart-like swellings and excrescences varying much in shape and size as shown in

Figure 2. While they injure the twigs and branches by causing an abnormal growth of the infested portion, resulting in the formation of a rough and pitted surface, yet this pest does considerable more damage upon the roots than upon the branches of the apple tree.

Remedies: When woolly aphid is on the roots of apple trees, dig a trench around them and put in the trench a liberal supply of finely ground tobacco, refilling with earth immediately after. This will have the effect of clearing the roots of this pest. The ground tobacco stems or coarse tobacco will not answer, it must be finely powdered. When occurring on the branches, spraying the trees with kerosene emulsion, 15 per cent., or whale oil soap at the rate of one pound to four gallons of water will destroy the pest.

Fig. 2—*a*, an apple root, showing knots, caused by the work of the insect; *b*, a colony of aphids on a root; *c*, a louse.

after the aphid becomes established in a soil it is difficult to effect its complete eradication.

#### ATTACKING THE TRUNK.

#### ROUND-HEADED APPLE-TREE BORER.

#### *Saperda candida* Fab.

Description: The adult beetle is about three-quarters of an inch long, cylindrical in form, of a pale green color, with two broad, creamy-white stripes running the whole length of its body. The females are larger than the males. Figure 3 shows an adult beetle and larva.

Life History: The insect winters in the larva state during which time it is in a dormant condition. It is generally conceded that the larva of this beetle requires three years to reach maturity. In the spring of

the third year it changes to a pupa, and two or three weeks afterwards the adult beetle emerges, usually in June or July. The female then deposits her eggs around the trunk of the tree. The eggs hatch in

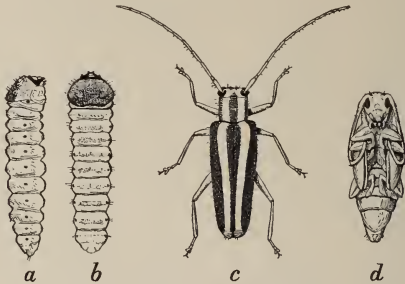


Fig. 3—The Round-headed Apple-tree Borer; a, larva from side; b, from above; c, female beetle; d, pupa; all enlarged one-third.

about two weeks and the larvae at once commence to gnaw their way into the interior of the tree.

**Nature of Injury:** The larvae do their injury by boring into the tree and making cavities between the bark and the wood and later by boring deeper into the wood of the tree. The bark of young trees often becomes dark colored and dead which is a good sign of the presence of borers. Often several can be found in a single tree.

**Remedies:** When the trees are found to be infested with this borer, the ground should be taken from around the base of the tree, and the borers cut out. If they cannot be reached with a knife a stout wire is often used to push into their holes, and if extended to its terminal will kill the larvae.

**Preventative Measures:** The application of alkaline washes to the trunk of the trees is probably the most efficient, since experiments have demonstrated that they are repulsive to the insect and will prevent the female beetle from laying her eggs on the trunks of the trees. Soft soap or whale oil soap at the rate of two pounds to the gallon of water applied to the bark of the trees, especially at the base or collar and up the trunk to the crotches, will cover the surface liable to attack. The soap solution should be applied early in June, and a second time during the early part of July.

## FLAT-HEADED APPLE-TREE BORER.

*Chrysobothris femorata* Fab.

**Description:** This is a flattish oblong beetle of a shining greenish black color, each of its wing covers having three raised lines extending longitudinally down them, transversely by brass-colored spots.

**Life History:** The life history of this borer is similar to the above species, except that it is usually conceded that the insect reaches maturity in one year.

**Nature of Injury:** The injury occasioned by the flat-headed borer is similar to that of the round-headed borer.

**Remedies:** The remedies and preventatives suggested for the round-headed borer will be applicable to this insect.

## ATTACKING THE BRANCHES.

## FRUIT-TREE BARK-BEETLE; SHOT-HOLE BORER.

*Scolytus rugulosus* Ratz.

**Description:** Figure 4 shows the adult beetle which is black in color, about one-tenth of an inch in width and three times as long. In the figure is also shown the larva and pupa of the insect. It is commonly called the "shot-hole borer" from the fact that the holes bored into the trees are about the size of small shot.

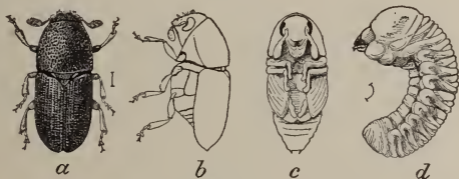


Fig. 4—The fruit-tree bark beetle; a, adult beetle; c, pupa; d, larva.

**Life History:** The beetles appear in early spring about the first of April or later in May and may be seen crawling about orchard trees attacking the young twigs and later the larger limbs and trunk. On reaching the sap wood the females construct galleries along the sides of which they gnaw little pockets where the eggs are deposited. In a few days the eggs hatch and the larvae according to Prof. Chittenden, United States Department Agriculture, are about twenty days attaining maturity. The period of the pupa state, as observed by Prof. Chittenden is about seven days, and thus we have the life cycle to be from about four to six weeks. There are probably three or four generations

during a season. Figures 5 and 6 illustrate the manner in which the insects riddle the wood beneath the bark.

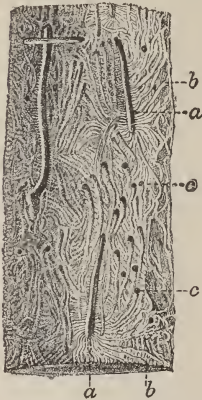


Fig. 5—Showing galleries of fruit-tree beetle under bark of twig.



Fig. 6—Showing work of fruit-tree bark beetle on a twig of apple.

Remedies: When a tree is found to be infested with this pest it is best to destroy it by burning. It is also of prime importance to destroy all brush wood and other trimmings of the orchard, as brush piles and the like offer ideal breeding places for the pest. If such be destroyed and the orchard trees be kept in vigorous health, they will more readily be able to withstand the borers' attacks. Many washes have been tried with little success; but if the insects are detected at the outset of their attack by touching lightly the affected parts, from which the gum has begun to exude, with a sponge saturated with kerosene emulsion, such damage may be prevented.

#### THE APPLE-TREE PRUNER.

#### *Elaphidion villosus* Fab.

Description: This is a long-horned beetle, cylindrical in form, of a dull blackish color, with brownish wing covers. The length varies from about one-half to three-fourths of an inch.

Life History: The female deposits her eggs in a small twig of a living tree. Upon hatching the young larva burrows into the centre of the twig and works towards its base. Upon reaching the larger branch and approaching maturity, it then proceeds deliberately to sever its connection with the tree by gnawing away the woody fibre to such

an extent that the first wind storm breaks off the branch. Completing its growth it transforms to the pupa stage within its burrow. Sometimes this change takes place in the autumn, but more frequently it is deferred until spring. The beetle emerges during the month of June.

**Nature of Injury:** The injury is occasioned by the larva boring into the terminal twigs and branches. It has been known to work in various trees, including the oak, hickory, chestnut and apple.

**Remedies:** When the insects become numerous they can easily be destroyed by systematic gathering and burning of all the fallen twigs and branches during the winter.

#### THE PERIODICAL CICADA—SEVENTEEN YEAR LOCUST.

*Tibicen septemdecim* Linn.

**Life History:** The most notable point of divergence in the life history of the periodical cicada from that of other insects is in its long subterranean life. While it is not necessary in this summary to give in detail its life history sufficient is it to say that it extends over a period of thirteen to seventeen years, according to their geographical location. Shortly after emerging the female insects begin the work of egg-laying,



Fig. 7.—Showing adult insects and nymphs of periodical cicada.

the real purpose of their brief aerial life of about six weeks (see Figure 7). The female uses all kinds of deciduous trees as repositories for

her eggs but seems to show a preference for the oak, chestnut and hickory, among the forest trees. However, almost any tree or shrub may be employed, it being more a question of availability than anything else.

Nature of Injury: It is its manner of egg-laying that causes injury from this insect, (see Figure 8), particularly on fruit trees, while

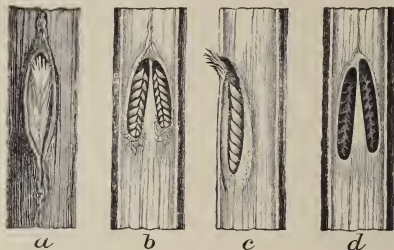


Fig. 8—Showing the manner in which the cicada deposits her eggs in the twigs.

not a little damage may be done to forest trees where the cicadas are abundant. The injury occasioned by the cicada is of two sorts, first where the terminal twigs eventually die from excessive oviposition and second in the case of other twigs or limbs which, while not killed, are so badly wounded that their future strength is greatly lessened. Many of these twigs recover to a certain extent, but there will remain a dead and weakened area in the center of the branches, which in the case of fruit trees, will give future trouble.

Remedies: When the insect occurs in great numbers there is nothing that can be done. As the year when they will occur can be foretold, the orchardists should anticipate their appearance and not plant fruit trees the year previous, as it is the young orchards which the insect especially injures. Orchards that border on woods will be troubled most with this pest. In nurseries the injury to young trees has been reduced to the minimum by killing the cicadas with a force of men, but this is rather an expensive remedy. A more detailed description of the cicada or locust is furnished in Bulletin 87 of this Station.

#### THE SAN JOSE SCALE.

#### *Aspidiotus perniciosus* Comst.

The description and life history of this pest having been given in Bulletin 90 from this Station, it will not be necessary to repeat it here. As is well known the insect has done a great amount of damage to apple orchards in Maryland, but now with the remedies at our command the pest can be controlled successfully.

A tree badly infested with the San Jose scale presents a somewhat

grayish appearance, as if it were coated with ashes, but to the ordinary observer, the tree would hardly seem to be infested unless very closely examined. However, if one should attempt to scrape the bark, this process would reveal the same to be covered with numerous little scales of varying sizes beneath which lay the small, oval, orange-colored objects, which are the true insects, and which do their injury by sucking the juices from the trees.

Remedies: Bulletin 99 from this Station discusses fully the reme-



Fig. 9.--Twig showing San Jose scale, magnified five times.

dies employed against this insect. It is only necessary to state that of all the sprays tested the regular lime, sulfur and salt wash proved the most efficient.

Figure 9 illustrates the appearance of the insect upon the bark of a twig.

## OYSTER SHELL SCALE.

*Lepidosaphes ulmi* Linn.

Description: As the name implies the shape of the scale is similar to the shell of an oyster, as shown in the accompanying illustration. The insect is very common in this State.

Life History: The insect winters in the egg state, the eggs being

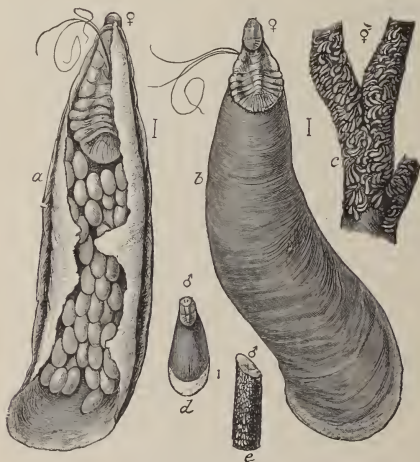


FIG. 10—The Oyster Shell Scale; a, female scale from below, showing eggs; b, same from above; c, female scales; d, male scale; e, male scale; enlarged.

laid under the scale late in fall. The eggs hatch in May or June, the young insects crawl out from under the scale and roam over the plant and on finding a suitable place, insert their beaks and commence to secrete material to form the scale over themselves. There is usually only one generation each year in this latitude.

Nature of Injury: As with other scale insects, the injury is occasioned by their sucking the juices from the plants they infest. It attacks a variety of plants and is particularly injurious to the apple in the extreme western part of the State.

Remedies: Infested trees may be treated in the winter with caustic washes such as whale oil soap, lime, sulfur and salt, etc., to corrode the scale and allow the eggs to be washed out by rain or destroyed by the climatic influences. The trees may also be treated in the late spring or early summer with contact insecticides, that will kill the tiny young. Kerosene emulsion, 15 per cent., or common soap solutions reduced in strength can be employed. Natural parasites assist in the destruction of this pest and oftentimes reduce its injury to a minimum.

#### THE SCURFY SCALE.

#### *Chionaspis furfura* Fitch.

Description: Seldom do we examine an orchard without revealing the presence of this scale insect. The appearance of the scale is quite different from the oyster shell, as shown in Figure 11.

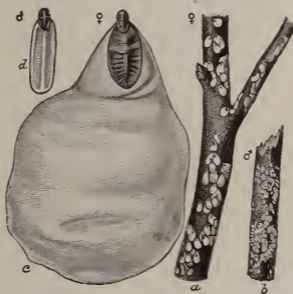


Fig. 11—The Scurfy Scale; a, c, females; b, d, males; a, b, natural size; c, d, enlarged.

Life History and Nature of Injury: In its life history and manner of injury this scale is similar to the oyster shell.

Remedies: The same remedies suggested for the oyster shell scale will be effective in controlling this pest. There is also a natural parasite which assists in destroying this insect.

## ATTACKING THE LEAVES.

## APPLE-TREE TENT-CATERPILLAR.

*Malacosoma americana* Harris.

Life History: The insect winters in the egg state, the egg masses being easily seen on the twigs of the apple trees. The larvae (see Figure 12) hatch in early spring and form peculiar tents, soon after birth, upon the nearest fork of a twig. After feeding on the foliage during the day time, they retreat into the tent at night. There is one generation during the year.

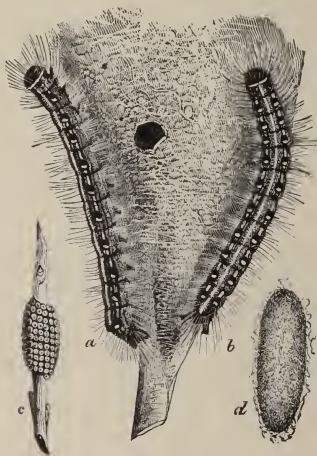


Fig. 12 — Apple-Tree Tent-Caterpillar; a, b, larva; c, eggs; d, cocoon.

Remedies: In trimming the orchard in the spring, care should be taken to destroy the egg masses of this insect. If the caterpillars should appear in early spring, they can be easily destroyed while sheltering within the tent. This can be done by a torch or the tent may be pulled off and the larvae killed. Applications of arsenites would also be effective.

## APPLE APHIS.

*Aphis* Sp.

**Life History and Nature of Injury:** The insects winter in the egg state; the eggs being laid on the terminal buds. When the buds begin to develop, the eggs hatch and the young aphids commence sucking the vitality from the tender foliage. There are several species of aphids that attack the apple foliage in the spring. They are generally known under the name of green aphids. Very often these little insects do a great amount of damage to the older trees, by sucking the juices from their leaves, but they especially retard the growth of young trees.

**Remedies:** In trimming the trees in the spring, the twigs on which the eggs are laid should be cut off. If some escape notice, however, when the aphids appear in the early spring, according to the species, the twigs of trees should at once be sprayed with either fifteen per cent. kerosene emulsion or "rose leaf," a tobacco extract, diluted to one part of the extract to 40 or 50 of water.

## THE WHITE-MARKED TUSSOCK CATERPILLAR.

*Hemerocampa leucostigma* S. and A.

**Description:** While the larva of this insect is usually more troublesome in cities and towns, attacking shade trees, yet at times it does injury in the apple orchard. The caterpillars are rather pretty creatures with bright red heads and yellow bodies, bearing a series of dense, abruptly-cut-off brushes on the middle of the back.

**Life History:** The egg masses are usually deposited on the cocoons from which the females emerged and can be seen fastened to dried leaves, pieces of bark and twigs of either orchard or shade trees during the winter months. The eggs hatch about the middle of May, and the larvae commence feeding on the foliage of the tree on which they are located.

**Remedies:** The increase of this insect may be prevented by destroying the egg masses during the winter months. If larvae should appear arsenical sprays should be employed. While individual trees or groups of trees are likely to be attacked by larvae crawling from other nearby trees, protection can be secured by banding the trunk with rolls of cotton. Since the females are not able to fly, they are prevented by the bands from ascending the tree and depositing their eggs. The larvae are also not able to pass this barrier. The bands may have to be renewed as they are sometimes injured by rain.

## THE FALL WEB-WORM.

*Hyphantria cunea* Drury.

Description: The adult moth is white, sometimes without spots or mark of any kind but usually with only a few black dots. The larvae when full grown are an inch or more in length and vary greatly in their markings; some are pale yellowish or greenish; while others are much darker. The body is covered with long, straight hairs, grouped in tufts. Figure 13 shows the general appearance of the larva, pupa and adult.

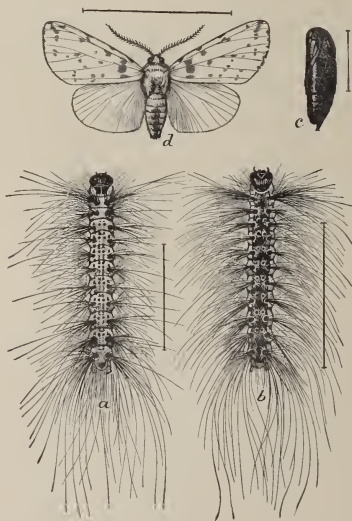


Fig. 13—The Fall Web-Worm; a and b, full grown larva; c, pupa; d, adult.

Life History: Throughout Maryland the insect is probably two brooded. The winter is passed in the pupa state in hibernation in the cocoons attached to the trunks of trees, fences or on rubbish here and there on the ground, or a short distance in the soil. The female moth flies at night and deposits her eggs in clusters of from 200 to 500 on

either surface of a leaf. The second brood appears about August and usually causes the most trouble.

Nature of Injury: The larvae are very troublesome in eating the foliage of a great variety of trees, including many of our shade trees. They feed in colonies, each colony spinning a web which sometimes becomes quite large, covering a large limb as shown in Figure 14.



Fig. 14—The Fall Web-Worm; suspended larva and sections of web

Remedies: From their birth, the web spinning habit of these larvae promptly leads to their detection, and as soon as seen they should be removed by cutting off a twig or branch and destroying it. In controlling these insects on a large scale, spraying the foliage with one of the arsenites will prove the most satisfactory.

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#### PISTOL CASE BEARER.

*Coleophora malivorella* Riley.

Description: Figure 15 represents the larva, pupa, and adult moth of the pistol case bearer. At "a" is shown curious little pistol shaped cases which contains the tiny larva, possessing the power of moving from place to place and carrying its protecting case with it. These cases are very tough and seem to be proof against the attacks of insect enemies. The moth is a very delicate creature, dark drab in color.

Life History and Injury: As the buds begin to swell the larvae cases will be found here and there sticking to their surfaces, while the

larvae within are busily devouring the interior. Later in the season the caterpillars leave the twigs and fasten themselves to the leaves on which they feed, sometimes reducing them to mere skeletons. Late in June they change to chrysalids and the moths appear on the wing in July. The moth flying at night deposits her eggs on the leaves, the latter hatching during August and September, the larvae living and

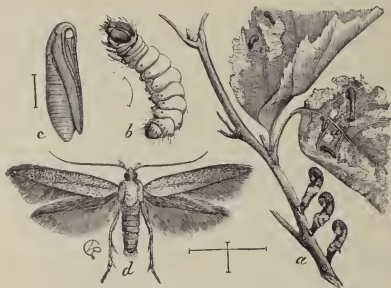


Fig. 15—the pistol case bearer; a, a, a, cases of different sizes with leaves as they appear when fed upon, natural size; b, larva; c, pupa; d, female moth enlarged.

feeding on the under side of the leaf until the appearance of frost when they migrate to the twigs, and fastening their little cases firmly with silken threads, remain inactive until the following spring.

Remedies: Spraying with arsenites will prevent much injury; also trimming, cutting off and destroying the twigs upon which the larvae are attached, will prevent their attacks. However, seldom does this insect attract much attention.

#### APPLE-TREE BUCCULATRIX.

#### *Bucculatrix pomifoliella* Clem.

Description: The presence of the insect is first discovered usually in the fall or winter by the appearance of many little white, longitudinally ribbed cocoons about a half inch in length. Sometimes they are present in such numbers as to cover the surface of the twigs. The tiny larvae are peculiar in their habit of hanging suspended from the leaves by silken threads. The slightest motion of the leaf on which they are located will send them spinning downward. The adult insect is a tiny, brown moth about one-eighth of an inch in length.

Life History: Professors Slingerland and Fletcher give an excellent account of this insect in Bulletin 214, Cornell University. According to them, the insect, after wintering in the pupa state, appears about

the middle of May as an adult moth and after pairing commences depositing eggs on the under surface of the leaves. In six to ten days, the larvae appear and commence their work of destruction. There are apparently two broods in this latitude.

**Nature of Injury:** The tiny larva does its injury by mining in the leaf under the skin until it attains full growth, when it eats a hole in the skin of the leaf and emerges on the upper surface. A short time afterwards it commences to spin its cocoon.

**Remedies:** The cocoons of the second brood remain attached to the trees all winter and therefore can be destroyed. Spraying the trees when dormant with the lime, sulfur and salt wash or whale oil soap, two pounds to the gallon of water, would penetrate the cocoon and destroy the insect within. Parasites aid materially in holding this insect in check. When the larvae appear in large numbers, spraying the foliage with an arsenite will also be effective.

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#### RED-HUMPED APPLE-TREE CATERPILLAR.

*Schizura concinna* Sm. and Abb.

**Description:** The caterpillars sometimes occur in great numbers on a variety of plants. They are yellowish-brown in color, pale along the sides and striped with slender black lines. The fourth segment is humped and of a red color like that of the head.

**Life History:** It winters in the pupa state, the moth appearing late in June or early in July. The eggs are then deposited on the under side of the leaf, hatching soon afterwards into tiny caterpillars.

**Nature of Injury:** The caterpillars do their injury by eating the foliage of the apple, entirely consuming the leaves of the branch on which they are located.

**Remedies:** The suggestion for the control of other leaf-eating insects, that is, the application of arsenites will apply for this pest. They very seldom occur in numbers to warrant treatment.

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#### ATTACKING THE FRUIT.

##### THE CODLING MOTH.

*Carpocapsa pomonella* Linn.

**Life History and Injury:** This insect is the most injurious to apple fruit with which the growers have to contend. The insect does its damage by its larva boring into the apple and there feeding until it is ready to pupate. It then eats its way out and finds some crevice either on the bark of the apple tree or in the ground to make its change to the adult moth. There are apparently two broods in Maryland, the moth of the first brood appearing in early spring about the time apple

trees are in blossom. It then deposits its eggs either in the calyx end of the apple or on the leaves. The life history of the second brood is similar to the first. Figure 16 shows the larva, pupa, and moth, also the manner in which it injures the apple.

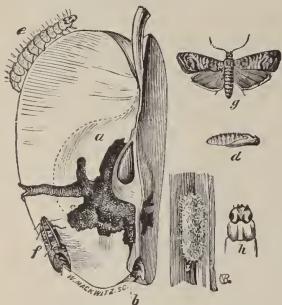


Fig. 16—The Codling Moth, a, apple showing burrow; d, pupa; e, larva; g, moth.

Remedies: Apple trees should be given one spraying with an arsenite just as the petals drop off the blossoms, so that the larva may get some of the poison as it eats its way into the apple. A second spraying about two weeks later would be desirable to catch the larvae from the later-appearing moths. The trees should also be sprayed about the first of July, in order to kill the larvae of the second brood. It is good policy to apply the poison in combination with Bordeaux mixture, one-quarter pound of Paris green or other arsenite to 50 gallons of Bordeaux.

#### THE PLUM CURCULIO.

##### *Conotrachelus nenuphar* Hbst.

Nature of Injury: One often notices apples being rough, having depressions and elevations on their surfaces. These are generally caused by the so-called plum curculio, a small beetle that after wintering in the adult state, appears in the spring and attacks various fruits, especially apple, peach, and plum. The insect does its injury by feeding on the foliage and fruits, and by the manner in which the female lays her eggs. In making the feeding punctures, the beetle eats a small, round hole, through the skin with its mandibles, which are situated on the end of its beak or snout. It then eats the pulp about one-tenth of an inch in depth, thus leaving a small, round hole in the apple. As this is done when the apples are small and growing rapidly, if disease does not attack the apple at this point, it will recover from this puncture, but there will always be a scar left. If the holes are made later in the season, the apple will not outgrow them so quickly and the scars become more prominent. While the male and female beetles feed in this manner, the greatest damage is done by the female in depositing

her eggs about the middle of May. In doing this she makes a crescent-shaped slit by eating some of the pulp, she elevates the small flap

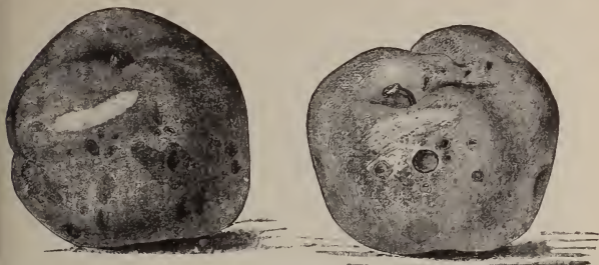


Fig. 17—Work of Plum Curculio on apple.

from the surrounding tissue, and in this she lays her egg. This crescent-shaped cut is shown in Figure 17 on the apple, and in Figure 18 on a plum; also the beetle, pupa and larva are illustrated.

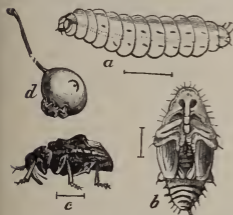


Fig. 18—The Plum Curculio; a, larva; b, pupa; c, adult; d, crescent shaped slit on fruit.

Life History: The eggs deposited in the cut hatch in a few days, and the white, grub-like larva bores at once into the centre of the apple, or other fruit on which it may be located. After boring around in the apple, which usually drops to the ground, the insect continues its life history by coming out of the apple and going into the ground to pupate, and emerges about the first of August as an adult beetle. The insect is single-brooded, the beetle hibernating in secluded spots..

Remedies: When the beetles appear in the spring, spraying the foliage of attacked trees with an arsenite will often prevent further injury to the fruit. When injuring the fruit, the "jarring method" of combating them can be employed with some relief. As the beetles fall to the ground when slightly disturbed, placing a sheet under the tree and jarring the latter suddenly will be the means of catching a great many of them. This work should be done in early morning, as the beetles are less active at that time. Care should be taken in jarring the tree not to scar it. A stout pole wrapped at one end with an old sack is generally used.

## THE APPLE CURCULIO.

*Anthonomus quadriggibus* Say.

Description: Though named the apple curculio, it is not so injurious to the apple as the plum curculio. The beetle is smaller than the plum curculio, of a dull-brown color and though oftentimes mistaken for the above species, it is easily distinguished by the long, slender, somewhat curved snout and by the prominent rust-red colored humps on the posterior portion of each wing.

Life History: The insect winters in the adult state, appearing in spring and depositing its eggs in the apple or pear, and continuing its life history in the same, the beetles appearing about the middle of July. Only one generation a year has been recorded.

Nature of Injury: When feeding, this insect makes a number of holes or punctures and around these a hard knot or swelling forms, which much disfigures the fruit; pears as well as apples are sometimes injured in this way. Of course fruit in which the beetle has laid its egg is rendered worthless.

Remedies: Picking the affected fruit from the tree and jarring the trees when the beetle is present will be means of reducing the numbers. Fortunately it is seldom found in such abundance as to do much damage to the fruit crop.

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INSECTS AFFECTING THE PEACH.

## ATTACKING THE ROOTS.

## THE BLACK PEACH APHIS.

*Aphis persicae-niger* Sm.

Nature of Injury: This insect occurs in two forms, one attacking the roots of peach trees, preferably young ones, the other attacking the foliage. It does its injury by sucking the juices of the trees both from the roots and foliage. Its injury is usually more apparent on young trees a short while after they are set out.

Remedies: The most efficient remedy when attacking the roots of young trees is the use of tobacco dust; digging away some of the earth from around the infested tree in order to place the dust in close proximity to the roots. Not only is tobacco dust a good insecticide but it is also a good fertilizer. Where this pest occurs on the foliage, spraying the infested parts with a strong tobacco decoction or with whale oil soap at the rate of a pound to four gallons of water will be effective.

## ATTACKING THE TRUNK.

## THE PEACH TREE BORER.

*Sanninoidea exitiosa* Say.

**Life History:** The adult insect, a slender dark-blue moth (see Figure 19), appears as early as May in this latitude and at once commences to deposit its eggs on the bark usually at or near the surface of the ground. The young larva upon hatching immediately burrows into the bark of the tree. It feeds steadily during the summer and



Fig. 19—The Peach Tree Borer; a, adult female; b, adult male; c, larva; d, pupa; natural size.

early fall. It winters in the dormant larva state and resumes feeding in early spring and upon reaching maturity it transforms to the pupa and in a few days the adult emerges.

**Nature of Injury:** We have in this pest an insect that does its injury in a somewhat similar manner to the apple tree borers. Its presence can be detected by the brownish, gummy exudations, more or less soiled with earth and the larva excrement about the base of the trees. The larvae mine between the bark and sap wood, just below the surface of the ground, sometimes completely girdling the trunk and causing the death of the tree, or always injuring and weakening it.

**Remedies:** It is advisable to examine peach trees in the fall and spring for the presence of the insect. When present at either time, the best remedy is to use the knife to cut them out or a stiff wire which can be thrust into their holes so as to kill them.

**Preventatives:** Among preventative measures, the placing of sheathing paper around the trunk of the tree, may be mentioned. Also applying to the trunk a heavy coating of whitewash, adding glue or soft soap, will aid in preventing the adult female from depositing her eggs. Mounding the tree with earth from eight to ten inches high after worming in the spring will give good results.

## ATTACKING THE TRUNK AND BRANCHES.

## THE FRUIT-TREE BARK-BEETLE.

*Scolytus rugulosus* Ratz.

This insect is described and illustrated under insects affecting the apple. It does its injury in the same manner on the peach and remedies suggested previously will serve in this case. See page 129.

## THE SAN JOSE SCALE.

*Aspidiotus perniciosus* Comst.

Likewise with this pest, the description and remedies previously given on page 8 will apply in controlling the insect on peach.

## THE WEST INDIAN PEACH SCALE.

*Diaspis pentagona* Farg.

Description: This introduced scale insect may in time become very troublesome to Maryland growers. At present the writer is not aware of any infested districts, but owing to the fact that the pest is present in injurious numbers in the District of Columbia, there is a possibility of its being distributed in Maryland orchards in that vicinity. The scale presents a grayish-white appearance, the female scale being some-

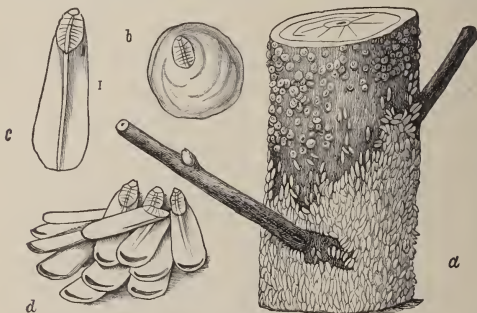


FIG. 20—The West Indian Peach Scale; a, branch covered with scale; b, female scale; c, male scale; d, group of male scales.

what circular in shape and about a millimeter in diameter, while the male scale is rather more than a millimeter in length and one-third as wide. Figure 20 illustrates the insect.

Remedies: No doubt the application of caustic washes such as lime, sulfur and salt or whale oil soap while the trees are dormant would control the pest.

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#### THE PEACH SCALE.

*Eulecanium persicae* Fab.

Description: This scale is frequently found in Maryland. As its name indicates it is usually found on peach. In some cases it is present in sufficient numbers to cause the fruit from infested trees to be small and insipid. Where the insects crowd the twigs abundantly a perceptible amount of honey dew is found to be excreted. A smut fun-



Fig. 21—The Peach Scale, showing twig with full grown females.

gus develops upon the honey dew, which sometimes covers the scale mass, and many of the scales are destroyed. It is much larger than the previously mentioned scale insects. Dr. Howard states in Year Book, 1894, that "The insect appears to winter mainly in the advanced female condition in which stage it is a hemispherical, slightly elongated, brown, rather hard object, 2.5 to 4 m. m. in diameter." See Figure 21.

Remedies: Spraying infested trees with lime, sulfur and salt wash in winter will control the insect. If not treated in winter, spraying trees about the latter part of June with fifteen per cent. kerosene emulsion will destroy many of the young.

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#### ATTACKING THE LEAVES.

#### THE BLACK PEACH APHIS.

*Aphis persicae-niger* Sm.

See page 144.

## ATTACKING THE FRUIT.

## THE PLUM CURCULIO.

*Conotrachelus nenuphar* Hbst.

This insect often punctures peaches when they are half-grown, causing scars on the fruit where juices exude and thereby often ruining the appearance of the mature peach. Remedies suggested on page 142 will likewise apply in this case.

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## THE FIG EATER—JUNE BUG.

*Allorhina nitida* Linn.

This is a green velvety beetle measuring from two-thirds of an inch to one inch in length. The insect is sometimes called the "June bug." The larvae feed upon the roots of grass and other plants. The adult beetles sometimes feed on ripe peaches as many as four or five often being seen on one peach.

Remedies: There is practically nothing that can be done against these insects other than collecting and destroying them.

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## INSECTS AFFECTING THE PEAR.

## ATTACKING THE BRANCHES.

## THE TWIG GIRDLER.

*Oncideres cingulatus* Say.

Description: Though sometimes injurious to the pear it by no means confines its work to this plant and possibly would be more properly considered under forest tree pests. The adult beetle varies from about eight to eleven-sixteenths of an inch in length, is reddish and ash-brown in color with a broad ashy belt nearly midway across each wing.

Life History and Injury: With this pest we have a peculiar egg-laying habit. The beetle lays an egg on a twig or on a branch and then girdles it at a little distance below, gnawing a groove about one-tenth of an inch wide and deep enough all the way round so that a high wind brings it down. The twig wilts at once, and the wood is then in the condition desired by the larva, which completes its life history undisturbed by growth. After wintering in the larva state, it reaches

maturity in the spring, the adult beetle appearing about the first of August, and commencing to deposit its eggs.

Remedies: Collecting and burning all the fallen twigs will subdue the insect.

#### THE PEAR-TREE PSYLLA.

*Psylla pyri* Linn.

Description: The psylla is a small, yellow, jumping creature flattened in form, and provided with short legs, a broad head and sharp beak.

Life History: The insect has several broods during the summer but winters as an adult in any available shelter.

Nature of Injury: In rare instances this insect occurs in immense numbers. It does its injury first, by sucking the juices of the plants, and so, weakening them, and second by exuding honey dew in such quantities as to close the pores of the leaves and young bark over which fungi develop. The insect attacks the stalk of the fruit, or the twig where it is fastened. This causes a cessation of growth, the tree losing most of its leaves.

Remedies: Spraying the pear trees in early spring just as the buds begin to swell, with whale oil soap at the rate of one and one-half pounds to the gallon of water will kill many of the adult insects as they emerge from their winter quarters. Also spraying with lime, sulfur and salt or kerosene emulsion would give good results.

#### THE SAN JOSE SCALE.

*Aspidiotus perniciosus* Comst.

See page 132.

#### ATTACKING THE LEAVES.

##### THE PEAR SLUG.

*Eriocampoides limacina* Ratz.

This is rather a common pest on pear trees. The larva is a very dark green slug and does its injury by scraping the upper side of the foliage until it dries and withers, falling to the ground in midsummer. Young pear trees are more apt to be injured. The insect passes the

winter in the pupa state under the ground; the adult flies appearing on the twig the latter part of May or the first of June.

Remedies: The insect is very easily controlled by spraying the foliage with an arsenite or dusting with air-slacked lime.

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#### THE PEAR LEAF BLISTER.

##### *Eriophyes pyri* Pagst.

Injury from this mite has been very conspicuous in pear orchards all over the State. The mite, which is an exceedingly small creature, is practically invisible to the naked eye. Its injury is done by forming little galls on the leaf, within which is a cavity affording a residence for the mites. On the lower side is an opening through which the mite that started the gall entered, and from which the young mites, developed in the gall, can escape in order to start new galls.

Remedies: As the mites live within the tissues of the leaves during the growing season, they are beyond the reach of ordinary insecticides. During this season the only means of combating the pest is to gather the infested leaves, either by picking or pruning and burn them. As the mite winters under the scales on the terminal buds, it is usually controlled by the annual pruning in early spring when the terminal twigs are cut off and destroyed. Prof. Slingerland (Cornell Bulletin, 61,) recommends spraying infested trees in winter with kerosene emulsion about ten per cent., being careful to hit the terminal buds.

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#### INSECTS AFFECTING THE PLUM.

##### ATTACKING THE TRUNK AND BRANCHES.

##### SAN JOSE SCALE.

##### *Aspidiotus perniciosus* Comst.

See page 132.

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##### ATTACKING THE FOLIAGE.

The larvae of several of our common moths sometimes feed upon plum foliage, and at times, in some localities in sufficient numbers to cause annoyance, but they are not of sufficient importance to enumerate them under this head. Some of them belonging to the family Sphingidae or Hawk-moths and Saturniidae or Giant Silk Worms will be listed in the discussion of the miscellaneous Lepidoptera.

## THE HOP VINE LOUSE.

*Phorodon humuli*, Schr.

This aphid resembles in its appearance and habits the apple tree aphid. It is, however, much less common. It is usually found on the under side of plum leaves extracting the juices and causing the leaves to become wrinkled and twisted.

Remedies: Spray infested trees with "Rose leaf," a tobacco extract, at the rate of one part of the extract to forty or fifty of water. Applications of kerosene emulsion, ten per cent., would also prove effective.

## ATTACKING THE FRUIT.

## THE PLUM CURCULIO.

*Conotrachelus nenuphar* Hbst.

A rather full discussion of the insect and the manner in which the fruit is injured is given on page 142 under the apple. There is no doubt however, that the insect generally attacks plums to a greater degree than any other fruit. The injury is occasioned on the plum as with the apple by the adult beetles puncturing the young fruit in securing food and by the adult female beetle in laying her eggs. Great injury is also caused by the larva feeding within the fruit.

Remedies: The suggestions as to its control given under apple will likewise apply in controlling its attacks on plum.

## SMALL FRUITS.

## INSECTS AFFECTING THE GRAPE.

## ATTACKING THE ROOTS.

## THE BROAD-NECKED PRIONUS.

*Prionus laticollis* Drury.

Description and Injury: This is one of our largest borers, being from two and one-half to three inches in length. They feed in the roots of a variety of trees and plants, including chestnut, oak, cherry, apple, blackberry, and grape. The larva requires about three years to reach maturity, when the adult beetle appears about middle of May.

Remedies: When grape vines suddenly die from an unknown cause, the roots should be carefully examined and if the work of this borer is apparent, it should be searched for and destroyed. There is no way of reaching the borer except by digging it out and destroying it at once.

## INJURING THE ROOTS AND LEAVES.

## THE GRAPEVINE ROOT WORM.

*Fidia viticida* Walsh.

Oftentimes great injury is inflicted by this beetle, as it feeds upon the leaves of the grape about mid-summer, eating irregular holes on the upper surface. Eggs are laid on the trunk of the vine or on the branches in any available crevice. Upon hatching the larvae drop to the ground and make their way to the rootlets upon which they feed.

Remedies: There is no efficient remedy for the control of the pest when it occurs in great numbers. Spraying the plants with an arsenite will kill many of the beetles. Having the ground in good cultivation, that is, by having a loose top soil without crevices leading to the roots, will prevent many larvae from reaching their food.

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THE GRAPE PHYLLOXERA.*Phylloxera vastatrix* Planch.

Description and Injury: Injury from this insect is very seldom noted in Maryland, although it has been a serious pest in other parts of this country, and especially in Europe. Occasionally we receive specimens of its work from different parts of the State. The life history of the pest being quite complicated, it will not be necessary to give it in detail here. Sufficient to say that the insect winters on the roots of grapes, mostly as a young wingless form. It does its injury especially upon the roots but usually wingless individuals leave the roots and crawl up the stems to the leaves, where they form the galls, which show that the plant is infested.

Remedies: This is one of the most difficult of the root lice to control when occurring in injurious numbers. Carbon bi-sulphide can be applied with a degree of success, by being injected around the roots that are infested. As it is stated that a number of the insects crawl over the surface of the ground during August and September, placing quicklime, ashes or some fertilizer rich in potash around about the vines may be helpful. When the galls are noticed on the leaves, they should be pulled off and destroyed. Our native vines are found to withstand the attacks of this insect much better than those of European origin. Care should be taken therefore in selecting stock.

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THE GRAPE SCALE.*Aspidiotus uvae* Comst.

Description: This is a rather small, flat and nearly circular scale, the color being yellowish-brown, a little lighter than the dry bark of the

vine. The insect infests the lower part of the grape vines from the ground to the shoots of the second year's growth.

Remedies: If this pest becomes troublesome spraying the vines with a strong solution of whale oil soap or other caustic wash would control it.

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#### ATTACKING THE FOLIAGE.

Likewise with the grape as with the plum, there are a number of caterpillars of some of our largest moths that feed on the leaves to some extent. Some of these will also be mentioned in miscellaneous Lepidoptera.

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#### THE GRAPE-VINE FLEA BEETLE.

*Haltica chalybea* Illig.

Life History and Injury: This little beetle, steel blue in color, is sometimes very troublesome in vineyards. It feeds on the leaves of the grape both in the larva and adult stages. In early spring the beetles feed on the tender buds as soon as they begin to swell. A little later the beetle lays eggs on the under side of the leaves. These hatch into little blackish, slender, slug-like larvae which continue feeding until reaching maturity. The larva then works itself into the ground and transforms into the pupa, the adult beetle emerging soon afterwards. The insect winters in the latter stage.

Remedies: This insect can be controlled by an application of a strong arsenical wash. Also spraying Bordeaux mixture upon the foliage (better in combination with an arsenite) will be found helpful as Bordeaux is distasteful to the insect.

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#### THE GRAPE LEAF FOLDER.

*Desmia funeralis* Huebn.

The larva of this small moth sometimes does injury by turning down a small portion of the leaf, feeding on the same within the tube

thus formed. As the larva increases in size a larger case is made, often the whole leaf being rolled into a large cylinder. The larva feeds on the leaf which it has folded, thoroughly skeletonizing it. The insect winters in the pupa state, the first moths appearing in June and deposit-



Fig. 22—The Grape Leaf Folder; a, male moth; b, female; c, larva; e, pupa; g, grape leaf folded by larva.

ing their eggs on the leaves of the vine. There are generally two broods each season in this latitude. The moth and its work is illustrated in Figure 22.

Remedies: The larva or pupa may be destroyed by going over the vineyard late in the season before the leaves fall and picking off the folded leaves and burning them. Although this insect is usually common it is seldom very destructive.

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#### THE ROSE CHAFER.

#### *Macrodactylus subspinosus* Fab.

Life History and Injury: This is a common insect appearing in June about the time roses and grapes come into blossom. The beetle feeds on their flowers in preference to anything else. They usually appear in swarms and remain about a month, at the end of which period, after pairing, the males die, while the females burrow in the ground a short distance and deposit their eggs. They then reappear and die soon afterwards. The eggs hatch in about three weeks and the larvae feed on the tender roots, remaining under ground until the following spring,

when they transform to pupae and the adult beetles appear as before mentioned. Figure 23 shows the beetle and larva.

Remedies: It is an exceedingly difficult insect to combat and when they occur in great swarms we are helpless. The arsenites act very



Fig. 23--The Rose Chafer; a, beetle; e, pupa; f, injury to leaves and blossoms, with beetle.

slowly upon this beetle, and they cannot be killed by a contact insecticide. In the morning the beetles are comparatively sluggish and inactive, and may then be jarred from the vines, on to sheets and collected and destroyed.

#### INSECTS AFFECTING THE CURRANT AND GOOSEBERRY.

##### ATTACKING THE STEMS.

##### THE IMPORTED CURRANT-BORER.

##### *Sesia tipuliformis* Clerck.

Description: Currants and gooseberries have no greater enemy than this borer. The adult is a very pretty moth, about the size of the moth of the peach borer, the wings having markings with purplish reflections. The larva is of a yellowish color, with a horny head.

Life History and Injury: According to Luger the eggs are deposited on canes, at least one year old, about June. Hatching, the

larva soon bores into the cane and there commences its work by eating out the interior of the cane forming a tunnel sometimes several feet in length. It hibernates in this secluded place. At the approach of spring, it continues its work until reaching maturity when it bores a little hole for the exit of the adult moth and then changes to the pupa state, the moths appearing in May and June.

Remedies: There is practically no remedy for the control of this insect except cutting out and destroying canes when they show the signs of attack. Careful pruning and destroying the canes will aid in combating the insect.

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#### SAN JOSE SCALE.

*Aspidiotus perniciosus* Comst.

This scale is often found on currants and it seems to increase as rapidly on this food plant as any other.

Remedies: The application of lime, sulfur and salt or whale oil soap to the bushes in the late winter will control the pest.

---

#### ATTACKING THE LEAVES.

#### IMPORTED CURRANT-WORM.

*Pteronus rebesii* Scop.

Life History and Injury: This is perhaps the most troublesome of all insects the currant grower has to encounter. The adult saw-fly appears in early spring and after pairing the female commences to deposit her eggs on the under side of the leaves, on the larger veins, in rows. In about ten days the young larvae hatch and commence feeding, at first eating small holes in the leaves, feeding in companies of from twenty to forty on a leaf, so that soon the leaf is completely destroyed. They then part company and spread in all directions over the bush. There are two or three broods during the season depending on the latitude. The insect winters in the larva or pupa state.

Remedies: When the larvae appear, thoroughly drenching the branches with white hellebore used at the rate of one ounce in one gallon of water or applying it in the form of dust, would be effective. Application of arsenites would also meet the desired ends.

## INSECTS AFFECTING THE RASPBERRY AND BLACKBERRY.

## ATTACKING THE CANE.

## THE ROSE SCALE.

*Aulacaspis rosae* Bouche.

Although this is called the rose scale, it does not confine its attacks to the rose, but is found on many other plants belonging to the same family. The scale is white and measures nearly one-eighth of an inch in diameter. It may easily be detected upon the cane of either raspberry or blackberry.

Remedies: This scale can easily be controlled by the application of a strong soap solution or kerosene emulsion at the rate of fifteen per cent.

## THE BLACKBERRY ROOT-BORER.

*Bembecia marginata* Harr.

The larva of this moth often attacks the canes of raspberry or blackberry by boring in at the surface of the ground and then working up or down gradually, channels the cane to the root, in which it spends the winter months, forming before spring, cavities of considerable extent. Its presence can be detected by the sudden wilting of the plants. The insect remains in the cane until September of the second year of its life, when it changes to a pupa within the stalk and emerges as an adult insect.

Remedies: When a plant shows signs of wilting or dying it should be removed and destroyed, thus killing the larva.

## INSECTS AFFECTING THE STRAWBERRY.

## ATTACKING THE ROOTS.

## THE STRAWBERRY ROOT-LOUSE.

*Aphis forbesi* Weed.

This pest is an exceedingly common one in Maryland and no doubt in the future more injury will be occasioned if vigorous methods are not employed against it.

The dark-green aphid can be found feeding on the roots of strawberries from spring until late fall. When the adults come to the surface, the female lays her tiny black eggs upon the stem of the leaves.

Remedies: There are many remedies suggested for the control of this insect. Among the most successful is the burning over of the strawberry patch in late winter, thereby destroying the eggs which hatch in early spring. Care should be exercised in burning over the plants not to allow the fire to remain in one place for too long a time. It is best to burn the patch when a slight wind is blowing, as, after placing a little straw upon the rows, the fire will run over it quickly, burning the foliage but not injuring the plants.

This is the only practical remedy after the plants are set out. Plants taken from infested patches should either be dipped in tobacco water, one pound to the gallon of warm water, or they should be fumigated with hydrocyanic acid gas at about fifteen hundredths grams of cyanide to the cubic foot of space, before being planted out.

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#### WHITE GRUB; JUNE BEETLE.

##### *Lachnosterna arcuata* Sm.

Nature of Injury: These beetles are exceedingly numerous in the spring. They fly at night and are readily attracted to light. There are many closely-allied species, all usually chestnut-brown or yellowish in color. Sometimes, when they are numerous, they do injury by eating the foliage of trees or shrubs. But more injury is occasioned by the larvae which live on grass and other roots, and are typical white grubs. We have received several reports of the larvae injuring strawberry roots.

Remedies: When present there is nothing that can be done except to pursue the cleanest of cultural methods, frequent rotation of crops and fall plowing. A heavy top dressing of some salty fertilizer such as kainit and nitrate of soda may prove beneficial.

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#### ATTACKING THE FLOWER.

##### THE STRAWBERRY WEEVIL.

##### *Anthonomus signatus* Say.

Description: This is one of the most troublesome pests to strawberry growers in the State. As shown in the accompanying illustra-

tions, Figures 24 and 25, the beetle is rather small, dark-brown or black in color and its mouth parts situated on an extended snout.

Life History: According to Prof. F. H. Chittenden, of the Bureau of Entomology, U. S. Department of Agriculture, the insect winters over in the adult state, emerging from its winter quarters a few days



Fig. 24—Strawberry weevil, dorsal view, much enlarged.



Fig. 25—Strawberry weevil, side view, much enlarged.

before the blooming of strawberry plants. The female selects an unopened, nearly mature flower, which she perforates with her beak and in each hole an egg is deposited down in the bud. She then crawls to the flower stalk, and cuts it in such a manner that it will fall over and hang by a mere thread or skin. (See Fig. 26). The bud falling to the ground



Fig. 26—Strawberry weevil; a and b, showing work on spray; d, larva; f, pupa.

a little later is kept moist, thus facilitating the growth of the larva. The larva completes its growth in about three weeks. The pupa stage is entered within the bud, and a little later, five or eight days, the adult beetle cuts its way out. The entire life cycle requires about twenty-eight days. The beetles of the new generation feed on the strawberry or probably some similar flower in immense numbers, but disappear after a few days to their hiding places for hibernation.

Remedies: There is no practical remedy for this pest at our command. Some relief may be secured by planting varieties which are profuse bloomers and giving preference to those varieties which show least injury from attacks by the insect. Cleaning all rubbish from around the patch and places where the adult beetle may hibernate will be beneficial.

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## GRAINS.

### INSECTS AFFECTING THE CORN.

#### ATTACKING THE ROOTS.

##### THE CORN ROOT-WORM.

##### *Diabrotica duodecempunctata* Oliv.

The larva of this beetle attacks among other plants, the roots of corn, especially in the Southern States. According to Dr. Smith there are two broods and the beetles winter in the adult state.

Remedies: The pest can be controlled by rotation of crops. So far as known they have never been injurious to corn after a previous crop of some other grain or vegetables. Prof. Quaintance (Bul. 26. Div. Ent. U. S. Dep't Agric.) recommends the planting of more corn in each hill and also planting the crop as late as possible in the spring.

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##### THE CORN-ROOT LOUSE.

##### *Aphis maidis-radici* Forbes.

These tiny lice may be found in masses on the roots of some corn plants that show a somewhat sickly appearance. The root louse is of an oval form, and may be recognized by being of a bluish-green color, with a waxy bloom, and with slender tubes projecting from the posterior part of the abdomen. Usually when the lice are present in the cornfield, they are accompanied with small brown ants, which aid them in many ways.

Remedies: A judicious rotation of crops will have the effect, at least, to diminish the injury by the corn aphid by distributing its attack.

There has also been many observations going to show that wheat and oats and the smaller grass-like plants in general are commonly soon deserted by such corn aphids as commence to breed on them. Thorough cultivation of the cornfield before planting in order to destroy all weeds, especially smart-weed, will assist in the suppression of this pest. Applications of fertilizer to the soil will serve to support corn under the drain of aphid injury, especially by enabling the stunted plant to rally after the insects have begun to scatter. Breaking up the ant nests by plowing deep in the fall and harrowing will often be of much benefit.

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WHITE GRUB. MAY BEETLE.

*Lachnosterna arcuata* Smith.

The larva of this beetle often injures the young roots of corn. Remedies on page 158.

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WIRE WORMS.

*Melanotus communis* Gyll.

While the larvae of these beetles live usually on roots of grass, yet often because of scarcity of food they become troublesome, attacking the roots of different cultivated crops. The injury to corn is usually caused by the worm burrowing into the seed kernels, either before or after it has sprouted. Sometimes their attacks are so severe as to require planting a second time.

Remedies: When present these worms cannot be controlled. We can only employ the preventative of rotation of crops, fall plowing and not planting corn immediately after a grass sod.

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ATTACKING YOUNG PLANTS.

THE SPOTTED CUTWORM.

*Noctua c-nigrum* Linn.

This is one of our more common species belonging to the class of cutworms. It has been found injuring a variety of cultivated plants. It does its injury like most cutworms by partly or wholly cutting off the young plants at or about the surface of the soil. The majority of them work at night, which increases the difficulty of controlling them.

Remedies: In giving a remedy for the cutworms, we can only speak generally. When the worms are present, employing poisoned baits is the most satisfactory; that is, by placing either green vegetation, bran or other material, which has been poisoned with Paris green or some

other arsenite, in little heaps all over the infested fields, just before night. The worms appearing during the night will be attracted by the material which, after eating, will kill them. It is best, however, to employ the preventative measures of clean culture, fall or early winter plowing as the partly grown cutworms will be exposed to the action of freezing and thawing, which will destroy them. The application of salty fertilizers in the spring has also been found beneficial.

#### THE BLACK CUTWORM.

*Agrotis ypsilon* Rott.

This is another of the voracious cutworms attacking young tobacco and tomato plants, as well as being especially destructive to corn-fields and gardens. The remedies suggested above will equally apply to this insect.

#### THE CORN STALK-BORER.

*Diatraea saccharalis* Fab.

Nature of Injury: This insect does its injury as shown in Figure 28, by the larva boring into the stalks of corn, thereby weakening

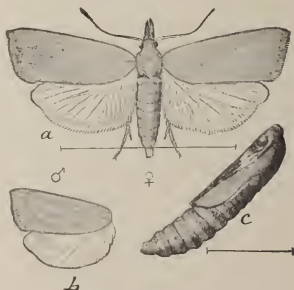


Fig. 27 — Corn Stalk-borer, adult female moth; c, pupa (enlarged).

them and where several occur in a stalk it is so injured that it may fall. In order to control this pest, it is necessary to be familiar with its life history.

**Life History:** The eggs are laid in the corn stalk by the moth after it appears in the spring. Upon hatching the larva bores through any leaves that encircle the stalk at the point where it is hatched until it reaches the interior of the stalk, then it may bore in many directions. There are probably three generations during the season. The insect hibernates in the larva state in the old corn stalk.

**Remedies:** While we can do nothing in the way of controlling it when it appears, all that is possible to do is to prevent its reappearance



Fig. 28—The Corn Stalk-borer; larvae in stalk of corn

the following season. The stalks should be cut for fodder early and all the remains not eaten should be burnt before February.

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THE STALK BORER.

*Papaipema nitela* Guen.

In this insect we have another enemy to corn as well as to various other plants. The insect does its damage in practically the same manner as the preceding species. However, in examining several infested stalks it is evident that the larva tunnels its way upward to a greater extent, eating out the center of the plants. The insect hibernates in the adult state and is, therefore, a hard one to control.

Remedies: As there is only one generation destroying the larva when they first appear will prevent its attack another year.

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ATTACKING THE EAR.

THE CORN-EAR WORM.

*Heliothis obscura* Fab.

Life History: An excellent account of this insect is given by Prof. Quaintance in Farmers' Bulletin 191, Department of Agriculture,

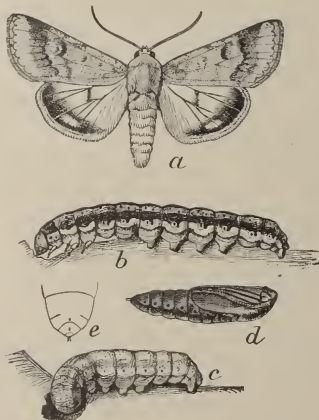


Fig. 29—The Corn-ear Worm; a, adult; b, dark full-grown larva; c, light colored full-grown larva; d, pupa, natural size.

and according to him its life history is as follows: Eggs are laid by the moth upon the silk of corn. They hatch in from one and one-half

to six days, depending on the temperature. The larvae are voracious feeders and grow rapidly, reaching maturity during summer in from twelve to fifteen days. It then leaves its food-plant and burrows two to five inches into the ground, where it pupates. The adult moth emerges nine to twelve days later. Thus the life-cycle may be passed in summer in from twenty to thirty days. Figure 29 shows the adult moth, pupa and larva of the corn worm.

¶Nature of Injury: This is the most destructive insect that affects the ears of either field or sugar-corn. It is more injurious to the latter than to the former. It is known under many names, and is a most serious enemy in the south to cotton, where it is known as the "cotton-boll worm." It also attacks tomatoes, when it is designated as the "tomato worm." Its injury to corn is caused by the larva feeding on the ear.

Remedies: There is no practical remedy for combating this insect upon corn. After ascertaining the correct time when the moths of each generation appear in a given locality, as they lay their eggs upon the fresh silk of corn, planting corn at a time when it has either passed this stage or has not yet reached it, may prove beneficial. Also deep plowing in the fall may assist in its control to some extent as the insect hibernates in the pupa stage in the ground.

#### INSECTS AFFECTING THE WHEAT.

##### ATTACKING THE STEM.

##### WHEAT JOINT-WORM.

##### *Isosoma tritici* Riley.

The adult hymenopterous fly lays her eggs on the stem of wheat, the larva, upon hatching, works at the joints in the stem, thereby weakening it and causing the head to fall over. According to Sanderson the larva of this species hibernates in the wheat stubbles, reaching maturity about June.

Remedies: Where the insect becomes injurious, plowing down or burning off the stubble will prevent further injury.

#### THE HESSIAN FLY.

##### *Mayetiola destructor* Say.

Description: This is the most serious insect pest that attacks the wheat plant, and while the amount of injury is irregular, it has been the cause of enormous loss to wheat growers not only in this State but many others. The adult insect is a small fly, dark-colored, and about one eighth of an inch in length.

Life History: The adult female lays her eggs on the young plants in the fall and the larvae work their way into the stem at or near the surface, causing a slight enlargement at the point of attack. When the weather becomes cold, the larvae have reached maturity and enter the

so-called "flaxseed stage." The adults from the wintered-over flaxseed puparia emerge during April or May. This is repeated and the flaxseed stage is reached before harvest. They are usually found low



Fig. 30—The Hessian Fly and its various stages of development; a, an egg; b, larva; c, pupa; d, pupa; e, adult all enlarged.

down in the stalk so that they remain in stubble when the grain is cut. They remain there until fall when by the usual changes the adults appear about the time the wheat sprouts.

**Nature of Injury:** Signs of attack from this insect are stunting, a yellowish color of the wheat plants in the fall, and the weakening of the stalks in the spring so that they fall or "lodge" readily which prevents the development of the grain. The Hessian fly and its transformations are shown in Fig. 30.

**Remedies and Preventatives:** Among the preventative measures are plowing the stubble as soon after harvest as possible and planting the wheat late in the fall in order that the adult flies may deposit their eggs upon grasses and thus the wheat may escape from serious injury. Some relief may come from pasturing an infested field in the late fall or early spring with sheep, as they may destroy many of the so-called flaxseed.

## INSECTS AFFECTING STORED GRAIN.

### THE ANGOUNOIS GRAIN-MOTH.

*Sitotroga cerealella* Oliv.

**Life History and Injury:** One of the common insects affecting



Fig. 31 — The Angoumois Grain-moth; a, full-grown larva; b, pupa; c, moth; f, grain of corn cut open to show larva at work.

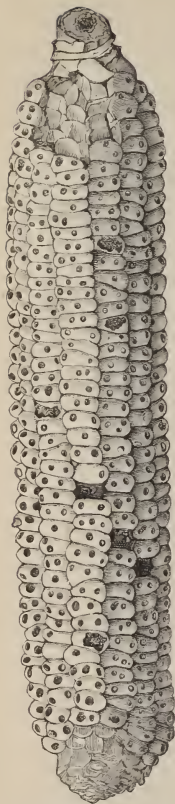


Fig. 32—Ear of Corn showing work of Angoumois grain-moth.

the kernels of grain is the Angoumois grain moth. Its injury in the South has been more apparent than in the North. The adult moth, (see Fig. 31) which is similar to the clothes moth, lays her eggs in clusters of 20 to 30 in the longitudinal grooves on the side of the grain. The eggs hatch in from five to eight days, the larvae at once boring into the kernel. In a short time the larvae reach maturity and after changing to the pupae, the adult moths emerge. The species continues to reproduce during winter if the temperature be warm enough, the number of broods being dependent upon the latitude and weather conditions. Sometimes grain is attacked in the field, that is, the moths appear and deposit their eggs upon grain before harvest. They continue to multiply after the grain is stored. The injury to corn is shown in Fig. 32, which not only causes enormous loss in weight but renders the attacked grain unfit for milling purposes. It attacks both corn and wheat and other grains.

Remedies: Grains should always be kept in a tight house, or bins, in order to prevent these moths from getting in it and laying their eggs. If they are not noticed before the grain is stored, or if they develop later, fumigating the infested grain with carbon bi-sulphide, one pound to 100 bushels of grain will kill them. Often this has to be done several times to eradicate the pest. Much care should be exercised in using carbon bi-sulphide as it is an exceedingly inflammable liquid. In using carbon bi-sulphide take care to have the enclosure fairly airtight. Pour the liquid in shallow dishes or pans, placing the latter on top of the infested material. The gas being heavier than air will descend and permeate the mass of grain or other material, thereby killing the insects. Infested grain should be subjected to the action of the gas for about twenty-four hours; even longer will not injure it for milling purposes.

## GRANARY WEEVIL.

*Calandra granaria* Linn.

The so-called granary weevil is a small brown beetle about one-sixth of an inch in length and with a long snout, which it uses in boring into the kernels of the grain. There are several generations of this insect during a year, depending on the climate. It is such a well-known pest that further discussion is unnecessary.

Remedies: Cleanliness in the barn will aid in preventing the appearance of this insect. When it is present fumigation with carbon bisulphide will be effective.

## SAW-TOOTHED GRAIN-BEETLE.

*Silvanus surinamensis* Linn.

This cosmopolitan pest is often found in granaries infesting meal, flour and grain, in which it will breed. The beetle is dark in color, rather flat and can easily be detected by the six saw-like teeth on each side of the thorax.

Remedies: Same as for preceding insect.

## THE MEDITERRANEAN FLOUR MOTH.

*Ephestia kuehniella* Zell.

This is a comparatively recent pest in the United States. Its injury is occasioned in mills by the habit of the larvae forming cylindrical silken tubes in which they feed and transform to chrysalids. By this manner of web-spinning the flour which they infest becomes



Fig. 33—The Mediterranean Flour Moth; a, larva; b, pupa; c, adult, enlarged.

felted and lumpy, the machinery becomes clogged, necessitating frequent and prolonged stoppages. When the larva reaches maturity, which require from five to seven weeks, it leaves its original silken home

and forms a new web, which becomes a cocoon in which it changes to a pupa and adult, and according to Johnson about nine weeks are required for the transformation of the insect, reckoning from the time of the deposition of the egg to the emergence of the adult. There are several generations during the year depending upon the temperature of the mill or other places which it infests. The adult moth, pupa and larva are shown in Figure 33.

Remedies: Likewise with this pest, fumigation with carbon bisulphide is the cheapest and most efficient remedy where the insect is troublesome.

#### INSECTS AFFECTING THE TOBACCO.

##### ATTACKING THE YOUNG PLANTS.

##### THE GRANULATED CUTWORM.

##### *Feltia annexa* Tr.

Among the numerous crop plants which are either germinated in the field or transplanted that are subjected to the attacks of the cutworms, tobacco is not an exception.

The species is one of our common forms, the larva appearing about the time the plants are set out. The injury from this, as well as other species, often causes the grower much trouble in replanting his crop.

Remedies: See page 161.

##### THE BLACK CUTWORM.

##### *Agrotis ypsilon* Rott.

Remedies: See page 161.

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##### THE TOBACCO STALK-WORM.

##### *Crambus caliginosellus* Clem.

This, a common pest of corn, has been described by Prof. Johnson, in Bul. 20, n. s. U. S. Div. Ent., as doing serious damage to tobacco plants in southern Maryland. The writer has not observed this pest doing injury recently. According to Prof. Johnson the larva does its injury by hollowing out the stalks from the base of the roots to the branches of the first leaves. He states that "in examining wilted plants, they invariably found the larva at work either in the stalk or at the base of the plant just below the surface of the ground."

Remedies: Prof. Johnson recommends as preventatives that the growers of tobacco avoid planting upon grass or timothy sod; and that where grass-land is plowed down it would be well to put it in wheat or other similar crop before tobacco.

##### ATTACKING THE LEAVES.

##### THE TOBACCO FLEA-BEETLE.

##### *Epitrix parvula* Fab.

This common little foe of several garden plants as well as a troublesome one to young tobacco plants, appears about July attacking first the lower and then the upper leaves. They do their injury by eating

tiny holes in the leaves, not always entirely through the thickness of the leaf, but enough to make them the entrance points for fungi. The injury from the latter is oftentimes more serious than from the former.

Remedies: Prof. Chittenden has found that the larvae feed not only on the roots of tobacco, but also upon the roots of common night shade and jimson weed; therefore the destruction of these as well as other solanaceous weeds around the tobacco fields will be beneficial in reducing the number of these beetles. Spraying the young plants with Paris green, one pound to 150 gallons of water, will give relief when the insect is troublesome.

#### THE TOBACCO HORN-WORMS.

1—*Phlegethontius sexta* Joh.

2—*Phlegethontius quinquemaculata* Haw.

Description: The larvae of these moths may be considered the



Fig. 34—The Tobacco or Tomato Horn-worm; a, adult moth; b, full-grown larva; c, pupa, natural size.

most troublesome pests of tobacco in this State. Every tobacco-grower is familiar with the large green worms that attack the leaves of tobacco

plants during June and July and even later. The two cited above are practically indetical as regards their life history and manner of doing injury and in fact the casual observer does not distinguish between the two different kinds of horn worms. Both are green in color with white stripes on the sides of the body. The pupae of these worms are easily recognized by the handle-shaped process which issues from the top of the head as illustrated in Figure 34 of *P. quinquemaculata*.

**Life History:** The moths that appear about May or later, according to the climate, from the pupae which have remained in the ground over winter, appear very much alike in color and markings; that of *P. sexta* is darker and the orange spots along its side are more pronounced than in *P. quinquemaculata*. They lay their eggs singly upon the lower surface of the leaves. The eggs hatch in from four to eight days according to Prof. Alwood's observations of *P. sexta*, (Howard, Farmers' Bul. 120, U. S. Dept. Agri.) and the larvae commence feeding upon the tender leaves at once. According to Howard, the larvae become full-grown in less than a month, they then burrow into the soil and transform to pupae. In Maryland there are usually two generations. These worms are known by many as tomato worms, as both species attack this plant.

**Remedies:** When these worms are numerous, spraying the plant with Paris green or other arsenite will give relief. "Hand picking," that is picking the worms from the leaves, is employed by some growers. Allowing a flock of turkeys to work in the tobacco field will be helpful as they are fond of the worms.

#### THE FALSE BUD-WORM.

##### *Heliothis obscura* Fab.

This insect which has been cited as injuring corn is also a pest of the tobacco, when it is known as the false bud-worm. While preferring corn as its food plant, when the ears upon which it has been feeding become too hard for easy attack, it then transfers its attention to other crops. It is then that it attacks the tobacco; the larva boring into the bud. As the leaves grow, these holes become larger and the leaves are thus ruined for sale as best grade. Later in the season they may bore into the ripened seed-capsules, destroying the immature seed.

**Remedies:** Spraying the plants with an arsenite will be of some advantage in controlling the pest. In Florida, Prof. Quaintance recommends sprinkling poisoned corn meal in the buds. Tobacco-growers are not especially troubled with this pest in Maryland, and it would seldom be necessary for the above remedies to be employed.

## THE CIGARETTE BEETLE.

*Lasioderma testaceum* Dufts.

While this insect is called the cigarette beetle, its ravages are by no means restricted to cigarettes. It makes no distinction between any kind of cured tobacco, but it may be said that its work is more serious

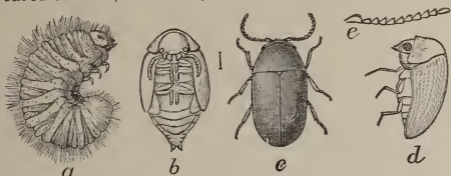


Fig. 35—The Cigarette Beetle; a, larva; b, pupa; c, adult; d, side view of adult.

in the finished products, such as cigars and cigarettes. It does its injury by eating small holes in the leaf and riddling the stem and when occurring in cigars or cigarettes, the small holes which they eat through the



Fig. 36—Work of Cigarette Beetle in Cigarettes.

wrappers make them worthless from the consumer's standpoint. Figure 35 shows the beetle in all its stages and Figure 36 illustrates its manner of injury to cigarettes.

Remedies: Fumigating infested tobacco with carbon bi-sulphide or hydrocyanic acid gas, together with giving the store-house thorough cleaning, is the most practical manner of treating this pest.

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## VEGETABLES.

### INSECTS AFFECTING THE IRISH POTATO.

#### ATTACKING THE TUBERS.

Several species of white grubs and wire worms are often injurious in attacking the tubers immediately after the planting or later when the potatoes have formed.

Remedies: These insects have been mentioned previously and here, as well as in other cases, rotation of crops seems to be the most practical treatment.

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#### ATTACKING THE STALK.

##### THE POTATO STALK-WEEVIL.

*Trichobaris trinotata* Say.

Life History and Injury: At times this insect is very troublesome to potato-growers in this State. The injury is occasioned by the larva of the beetle boring into the potato-stalk and feeding either in the main stalk or branches. The beetles appear in the spring, the female puncturing a small hole with her beak and then making a little cavity, deposits her eggs. The eggs hatch in a short time and the larvae feed until mid-summer or later. It then changes to a pupa state, and later to the adult beetle, which remains in the potato-stalk during winter.

Remedies: The beetles may be destroyed by burning the potato vines as soon as the potatoes are dug. The insect may deposit its eggs in the stem of Jamestown weed, horse nettle, and possibly other members of the solanaceae; therefore these weeds should also be destroyed.

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#### ATTACKING THE LEAVES.

##### THE COLORADO POTATO-BEETLE.

*Leptinotarsa decemlineata* Say.

Without doubt this is the most troublesome insect pest of the potato, although it is the opinion of the writer that the insect will not be so troublesome in the future, as in the past. Especially during the past year, its numbers seem to have decreased.

Life History: The beetles hibernate in the earth during winter, appearing in spring as soon as the young plants are up. They immediately commence to devour the foliage and the female lays her masses of eggs on the under surface of the leaves. The eggs hatch in about

a week, and the larvae after feeding vigorously for about four or five weeks, go in the ground to pupate and appear again as adult beetles. There are usually three broods.

Remedies: Spraying or dusting the plants with Paris green or other arsenite is the most effective treatment..

### THREE-LINED POTATO-BEETLE.

*Lema trilineata* Oliv.

This insect though less common is very similar in habits to the Colorado beetle. Also the life history is very much the same except that the beetles of the second brood do not emerge until the following spring.

Remedies: Spraying or dusting the plants with Paris green or other arsenites.

### BLISTER BEETLES.

1—*Epicauta vittata* Fab.

2—*Macrobasis unicolor* Kby.

About mid-summer potato fields are attacked by blister beetles, the most common of them being the striped blister beetle or the "old fashioned potato bug." When appearing in great numbers they are very injurious and, if not given attention, will soon ruin a potato patch. It is a curious fact that the larva of these beetles may be called beneficial, as they feed upon the eggs of the grasshopper.

Remedies: Spraying or dusting with an arsenite will assist in controlling them, but when occurring in enormous numbers as they do at times, they can be destroyed by taking a brush and driving them from the patch into a heap of straw, and then setting fire to the straw.

## INSECTS AFFECTING THE SWEET POTATO.

## ATTACKING THE STEMS.

## THE DARK-SIDED CUTWORM.

*Euxoa messoria* Harr.

With this crop as well the preceding one, and many other truck crops, various species of cutworms are troublesome by their injury in

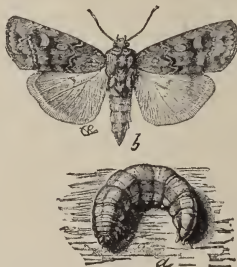


Fig. 37—The Dark-sided Cutworm: a, larva; b, moth.

cutting off the young plants soon after they are planted out.

Remedies: See page 161.

## ATTACKING THE LEAVES.

## SWEET POTATO FLEA-BEETLE.

*Chaetocnema confinis* Cr.

This is a small brownish-black beetle which attacks the young plants by eating small channels in each side of the leaf. From this injury the leaves soon dry up and decay. Thus the growth of the young plant is sometimes seriously impeded.

Remedies: Spraying the plants with an arsenite or better with Bordeaux mixture, with Paris green added, will control the beetles. Bordeaux mixture is distasteful to them. It is also recommended by many authors that dipping the plants in a mixture of arsenate of lead before setting will prevent injury from this as well as other insects attacking the plants in a similar manner.

## THE GOLDEN TORTOISE BEETLE.

*Coptocycla bicolor* Fab.

Description: This little beetle, which looks like a drop of molten gold, belongs to a class known as tortoise beetles, which from the broad expansion of their thorax (see figure 38) and wing-covers are fancied to resemble a tortoise. While the beetles included in this class belong to three different genera, they are very much alike in their habits and life history.

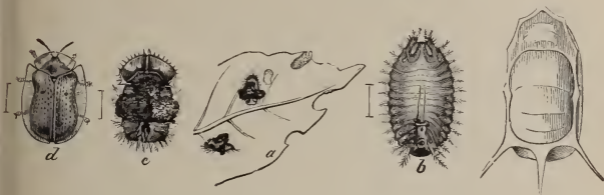


Fig. 38—The Golden Tortoise Beetle; egg at left, enlarged; a, b, larvae; c, pupa; d, adult beetle.

Life History and Injury: This insect hibernates in the adult stage, appearing in early spring feeding upon the morning glory. As soon as the young sweet potato plants are set out they commence their attacks on them, by eating round holes in the leaves. The female deposits her eggs singly on the stems and leaves. The eggs hatch about the first of June or later and the larvae require about two weeks to complete their growth. They then change to pupae, which are attached to the leaf. The adult beetle emerges in about a week, according to Sanderson, Bul. 59, Md. Expt. Station. He also states that the beetles remain for a very short time and then disappear until the following spring.

Remedies: The means suggested for the control of the flea-beetle will likewise prove the most satisfactory with these insects, that of dipping the plants in a solution of arsenate of lead before planting or spraying them immediately after planting with Paris green or other arsenite in Bordeaux mixture.

## THE TWO-STRIPED TORTOISE BEETLE.

*Cassida bivittata* Say.

This is also a most common species attacking the sweet potato



Fig. 39—The Two-Striped Tortoise Beetle; 1, larvae on leaf; 2, larva; 3, pupa; 4, beetle.

in a similar manner as the preceding species, Figure 39 shows the stripes on each wing-cover.

Remedies: Same as preceding species.

## THE BLACK-LEGGED TORTOISE BEETLE.

*Cassida nigripes* Oliv.

With the before mentioned tortoise beetles the larvae were not so injurious, as the plants are older when they appear; but with this species the larva seem to do more injury both on account of their larger size,

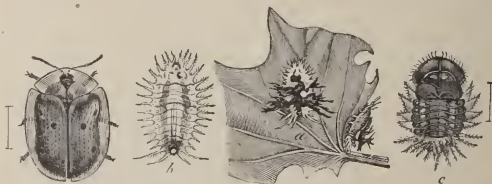


Fig. 40—The Black-Legged Tortoise Beetle; a, b, larvae; c, pupa; d, beetle.

manner of attack and the greater number on a single plant. The eggs of this species are laid upon the stem in rows of from three to a dozen. Figure 40 illustrates the beetle and larvae.

Remedies: Same as with preceding insect.

## THE MOTTLED TORTOISE BEETLE.

*Coptocycla signifera* Hbst.

Black with irregular golden spots and with a band of black, extending across the shoulders, distinguishes this beetle from the other species. It does its injury as do the other members of this class and is controlled similarly.

## THE ARGUS TORTOISE BEETLE.

*Chelymorpha argus* Licht.

This is the largest of the tortoise beetles attacking the sweet potato plant, and is shown in Figure 41. The beetle is also injurious to rasp-



Fig. 41.--The Argus Tortoise Beetle: a, beetle; b, eggs; c, larva.

berry and horse radish, but its common food plant is said to be the milk weed.

Remedies: It is controlled by arsenical sprays.

## THE SWEET POTATO PLUME-MOTH.

*Pterophorus monodactylus* Linn.

The larva of this moth is reported by Prof. Sanderson (Bul. 59, Md. Exp. Station) as injurious to the sweet potato plants by eating the foliage. They appear about the first of June or later. The insect requires about a month or more to complete its life history.

Remedies: As the insect does not appear until the plants have reached some size, their injury is not so apparent. If necessary arsenical sprays would control it.

## INSECTS AFFECTING THE TOMATO.

## ATTACKING YOUNG PLANTS.

## CUTWORMS.

The tomato is no less subject to the attacks of the cutworm than are many other crops. Grown in seed beds, as it is, and set out in newly-plowed fields, in summer, the plants are naturally attacked by the worms which for some days, at least, have existed in the soil, deprived of food. Many species have already been cited, therefore it is not necessary to give them here.

Remedies: See page 161.

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## THE CUCUMBER FLEA-BEETLE.

*Epitrix cucumeris* Harr.

This little beetle is often the cause of much injury to tomato plants, both when they are in the bed and also immediately after they are set in the field. Their injury is similar to that caused by the tobacco flea-beetle, that of eating small holes in the leaves of the plants.

Remedies: Spray the plants while growing in the bed with Bordeaux mixture adding Paris green at the rate of  $\frac{1}{4}$  pound to 50 gallons of the former. After the plants are set in the field a similar spraying would be advantageous.

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## THE TOBACCO FLEA-BEETLE.

*Epitrix parvula* Fab.

See page 170.

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## THE TOBACCO HORN WORMS.

1. *Phlegethontius sexta* Joh.

2—*Phlegethontius quinquemaculata* Haw.

A discussion of these insects is given on page 48, suffice it to say here that both species attack the tomato plant and are known commonly as the tomato worms.

Remedies: See page 171.

## THE TOMATO FRUIT-WORM.

*Heliothis obscura* Fab.

This insect is to be noted again under another common name, indicating the kind of fruit that it injures. Its injury to the tomato is caused by the larva boring into the fruit. One can often see the worm curled up in its hole in a green or half-ripe tomato. See Figure 27.

Remedies: When the worms are present there is nothing practical that can be done. Growers should prevent its reappearance next season by clean culture. Fall plowing is again advantageous by breaking up the little earthen cells in which the pupae are found under ground, thus exposing them to the action of frost.

## INSECTS AFFECTING THE MELON.

## ATTACKING THE YOUNG PLANTS.

*Flea-beetles.*

The different species of flea-beetles are often very troublesome to young melon plants. The remedies suggested under each species can be employed in this case.

## ATTACKING THE VINES.

## STRIPED CUCUMBER BEETLE.

*Diabrotica vittata* Fab.

This little beetle, shown in Fig. 42, is yellow, with black stripes on the wing covers. It does its injury by eating into the stem of the young plants. The larvae also live in the main roots under ground, often injuring them severely.

Remedies: This is a very difficult insect to control, and often we are at a loss to know what to do for the pest. A great many materials and washes have been suggested by growers and scientific workers, and among them, it is stated, that a free use of tobacco dust around the young vines or other injured plants is usually protective. According to Prof. Alwood, (Chittenden, Bul. 19, n. s. U. S. Dep't Agri.) spraying the hills with ten per cent. kerosene emulsion in early morning while the beetles are stupid and lie hidden under clods and around the stems will be beneficial. Prof. Gillette recommends dusting pyrethrum on the vines in early morning.

No doubt the species prefer cucumbers and accordingly in growing melons, the cucumbers could be grown as a trap for the beetles.



Fig. 42.—The striped Cucumber beetle.

## .THE SQUASH BUG.

*Anasa tristis* DeG.

Though called the squash bug, its attacks are by no means confined to that plant. Its injury to other cucurbit vines is very pronounced at times. The insect winters in the adult state under rubbish, bark of trees and other similar places. It appears in the spring, the female depositing her eggs on the lower surface of the leaf of the cucurbit, which it infests. According to Prof. Chittenden it requires from thirty-five to forty days to complete its life cycle. He also states that there is one generation during the year.

Remedies: As the insect winters in the adult state under rubbish, etc., cleanliness becomes advantageous in avoiding injury the following season. Where the pest has been troublesome, collecting the cucurbit vines just as soon as the crop is taken, and destroying them will be the means of killing or starving many of the immature bugs. Also employing some of the protective measures suggested for the striped cucumber beetle will be of some benefit.

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ATTACKING THE LEAVES.

## THE MELON APHIS.

*Aphis gossypii* Glov.

Life History and Injury: This pest has the peculiarity of appearing in large numbers one season, and possibly the succeeding one, the injury from the insect will be insignificant. When it appears in numbers it is a most serious pest to cantaloupe-growers in this State. In the spring, of all plant lice, this species appears to be the most susceptible to climatic variations, and this, in part, accounts for the variation in the abundance of the pest. Like many other plant lice it winters in the egg state, the eggs being deposited on numerous cultivated plants and weeds, which are in isolated places, such as fence rows, etc. The eggs hatch in the spring and the young aphids begin feeding on numerous plants in their reach. The number of food plants of this pest is enormous. Their increase depends upon the weather conditions and parasites. They do their injury by sucking the juices from the plants, infesting usually the under surface of the leaves. As stated previously they are especially injurious to cantaloupes, whole fields being sometimes practically destroyed by the pest.

Remedies: Growers should be on the watch for the first appearance of the insect in their cantaloupe patches, destroying the first infested hills. If the pest gains headway spraying the plants with fifteen per cent. kerosene emulsion will give some relief. The under side of the leaves should be sprayed which makes this manner of control rather impracticable.

## THE SQUASH LADY BIRD.

*Epilachna borealis* Fab.

As a rule members of the lady bird family of beetles (Coccinellidae) are beneficial, feeding on plant lice, scale insects, etc., but we have in this insect an exception to the rule. The adult beetle, and also the larva feed on the under side of the leaves, eating out the parenchyma and leaving the upper stems and veins more or less uninjured. The beetles, however, apparently prefer to feed on the upper surface, although, they may also be found on the lower surface of the leaf. Figure 43 shows the larva, pupa and adult beetle.

Remedies: Spraying the plants with Paris green or other arsenite will prevent injury from this beetle.



Fig. 43—The Squash Lady Bird; a, larva; b, pupa; c, adult; d, beetle.

## INSECTS AFFECTING THE CABBAGE.

## ATTACKING THE ROOTS.

## THE CABBAGE MAGGOT.

*Pegomya brassicae* Bouche.

While this pest is commonly known as the cabbage-root maggot, it by no means restricts its ravages to this plant, but usually confines itself to the Cruciferae or mustard family.

Life History and Injury: According to Prof. Slingerland, (Bul. 78, Div. Ent. Cornell Univ.) the adult fly appears in early spring and lays her eggs on the soil near the stem of the young cabbage plants, usually after they are planted in the field, although injury has been reported by this insect to plants in the bed. In a few days the eggs hatch and the young work their way to the tender rootlets, and when these are destroyed, the maggot works on the main stem, into which it burrows. Upon reaching maturity it pupates in the soil, a short distance from the roots. The fly emerges about three weeks later, and crawls to the surface. The female then commences to lay eggs for the second brood.

Remedies: Prof. Slingerland discusses at length the remedies that have been put forth by different experimenters, among the more important of which may be mentioned the placing of a tarred paper card around the plant, before setting into the field, to prevent the adult from laying her eggs or the larva from getting at the desired point. The application of crude carbolic acid to the plants after they are set, using the formula, one pound of acid to the gallon of water, will be beneficial. The pint of crude carbolic acid is poured into the water and the whole mass agitated into an emulsion, after which one part of this emulsion is diluted with thirty parts of water. The treating is done shortly after the plants are set out and repeated once each week or ten days until about May 15th. It is necessary to remove some of the earth from around the plant before treating. Carbon bi-sulphide may be injected into the ground around the plant, and has been used with some success. Good results can also be obtained with kerosene emulsion diluted to fifteen per cent.

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The cutworms and flea-beetles which have been mentioned previously can also be included as pests of the cabbage.

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#### ATTACKING THE LEAVES.

#### IMPORTED CABBAGE WORM.

#### *Pontia rapae* Sch.

Figure 44 represents the common butterfly that cabbage growers often see darting over their patches. The butterfly appears in early spring and at once commences laying its eggs on the cabbage, turnips,



Fig. 44—Imported Cabbage-Worm, adult male.

radishes or mustard. The larvae hatch from the eggs in about ten days and commence feeding on the leaves of the plant. Reaching maturity about ten days later, it changes to a pupa, the adult butterfly appearing in from eleven to fifteen days. There are many generations

during the season until finally, in the late fall, the insect either winters over in the adult or pupa state.

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THE CABBAGE PLUSIA.

*Autographa brassicae* Riley.

This insect does considerable injury to cabbage especially in the latter part of the season. The moths appear in the spring and lay their eggs similarly to the cabbage butterfly. The larva, in which stage the



Fig. 45—The Cabbage Plusia; a, caterpillar; b, chrysalis in cocoon; c, moth, male.

insect does its injury, is dark-green, but distinctly marked with longitudinal lines. Figure 45 shows the larva, chrysalis and adult.

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THE CABBAGE MAMESTRA.

*Mamestra trifolii* Rot.

THE ZEBRA CATERPILLAR.

*Mamestra picta* Harr.

The larvae of these moths are often seen in connection with the cabbage plusia and with the cabbage butterfly. Its larva can easily be distinguished from the others by a pinkish stripe down each side. The insects winter in the pupa state, the moths appearing in early spring.

There are at least two broods in this latitude. The larvae do their damage by eating the leaves and boring into the heads and stems of

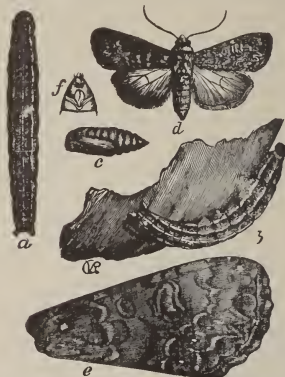


Fig. 46—The Cabbage Mamestra; a, b, larvae; c, pupa; d, moth; e, wing of same, enlarged.

the cabbage. They have the habit of usually feeding at night, remaining under stones and clods of earth during the day. The accompanying figure 46 illustrates the larva, pupa, and adult of *M. trifoli*.

#### THE DIAMOND-BACK MOTH.

*Plutella maculipennis* Curtis.

This active little pale-green larva about an inch in length (see figure 47) does injury at times by eating the outer leaves of the cabbage and other closely allied plants. The larva pupates within a beautiful, delicate gauze-like cocoon, through which the enclosed pupa

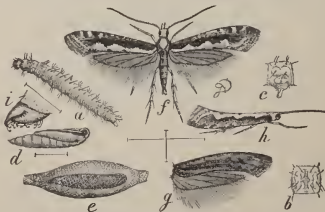


Fig. 47—The Diamond-back Moth; a, larva; b, pupa; c, cocoon; d, moth.

can plainly be seen. The adult insect is of an ash-gray color, with narrow wings, expanding about five-eighths of an inch.

Remedies: For cabbage worms. When the worms are present on the cabbage, without doubt Paris green or other arsenites are the most reliable remedies to be used. Some growers are afraid to spray their cabbage plants with an arsenite when they are half-grown, or larger; but there is not the slightest danger injuring any one by such procedure. In using Paris green, one-third of a pound to fifty gallons of water will be effective in controlling the pests. Slacking about a pound of lime and adding to the arsenical solution will cause it to remain on the leaves for a longer period. If, however, one should not like to use Paris green where the plants are heading, an application of hellebore will give good results and the poison will disappear more rapidly. Kerosene emulsion about fifteen per cent. can also be used with some success.

As a preventative against the attacks of these insects, planting turnips, radishes, or some other plant of the mustard family that flowers early in the season, on the border of the cabbage field, will attract the butterflies or moths, and possibly the pests could there be given more thorough treatment.

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#### THE CABBAGE PLANT LOUSE.

*Aphis brassicae* Linn.

A cabbage plant is often seen covered with these little lice, which suck the juice from the plants. The insects may winter in either the egg or adult state; the latter especially in pits where cabbage is stored. They appear in the spring and increase in enormous numbers.

Remedies: Injury can be prevented by a prompt removal of all plant remnants left in the field after the heads are taken out. Spraying infested plants with kerosene emulsion diluted to ten or fifteen per cent. or with a tobacco decoction will control them.

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#### THE HARLEQUIN CABBAGE BUG.

*Murgantia histrionica* Hahn.

Description: There is no doubt that this insect is the most troublesome which many gardeners have to contend with. It invariably appears each year in our cabbage patches, in enormous numbers. The adult (see figure 48) presents a bright mottled-red, yellow and black appearance which renders it conspicuous. The insect is nearly a half-inch long and about half as broad.

Life History and Injury: The bug winters in the adult state under rubbish or in such crevices as it may find large enough to crawl into. In spring it appears and feeds by sucking the juices of whatever cruciferous plants it may find. They are particularly fond of mus-

tard plants and will live on these until midsummer. Eggs are laid on the under side of the leaves and hatch in from four to ten days. The young larva at once begins feeding, thrusting its beak into the plant and extracting the juices, thus causing the plant to wilt and eventually die.

Remedies: Insecticides cannot be applied against the pest which are strong enough to kill the bugs without injuring the plants. Thus the planting of trap crops such as radishes or mustard around the edges of



Fig. 48—The Harlequin Cabbage Bug; a, eggs enlarged; b, young, more enlarged; d, adults seen from above and below, enlarged; f, parasite enlarged. Other figures natural size.

the proposed cabbage patch, before the cabbage plants are set out seems to give the best results. The insects will congregate on these plants and can be effectively destroyed either by applying a strong insecticide or by catching them. The precaution of clean culture, and cleanliness about farm buildings, fences, etc., will greatly reduce the presence of this pest the following season.

## INSECTS AFFECTING THE ASPARAGUS.

## ATTACKING THE FOLIAGE.

## THE ASPARAGUS BEETLE.

*Crioceris asparagi* Linn.

**Life History:** As soon as the asparagus shows itself in the spring these beetles, about one-fourth of an inch in length, with the wing covers black with red or yellow markings, appear from their hiding places over winter and at once commence to feed on it, and after pairing, deposit their eggs upon any portion of the shoots. The eggs hatch in from five to ten days, according to the temperature. The young larvae at once commence feeding vigorously upon the outer surface of the young shoots. They reach maturity, form cocoons and the adult beetles of the second generation appear in about two weeks time, thus completing the life cycle of the species in about three weeks during mid-summer, as reported by Prof. Chittenden, Year Book, U. S. Department Agriculture, 1896.

**Remedies:** At the first appearance of the beetles in the spring cutting down all the plants, thus causing the females to lay their eggs upon the young shoots, which are cut away every day, will prevent the appearance of the second generation as they are cut before the eggs hatch. It may be suggested that leaving a few shoots here and there would be advantageous if the beetles are numerous, as then most of them would deposit their eggs upon these shoots and they can be destroyed easily. A report from an asparagus grower last season states that he controlled the pest very easily by spraying the plants with Paris green. This has not been recommended as it is difficult to have the spray remain on the foliage of asparagus. It is better to apply the arsenite in powder form mixed with flour or plaster as that will stick to the leaves much better. Air-slacked lime is one of the best remedies against the larvae as it will kill all with which it comes in contact.

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 TWELVE-SPOTTED ASPARAGUS-BEETLE.
*Crioceris duodecempunctata* Linn.

**Description:** This pest first discovered in the vicinity of Baltimore has now spread both north and south and is nearly as common as the above mentioned species. The adult beetles are distinguished by the latter species having a much broader elytra (see Figure 49) and in its color. The ground color of *C. twelve punctata* is orange-red, each elytron being marked with six black dots. This beetle likewise ap-

pears in the early spring, the chief damage being done by the hibernating beetles in destroying the young asparagus.

Remedies: The remedies suggested for the regular asparagus

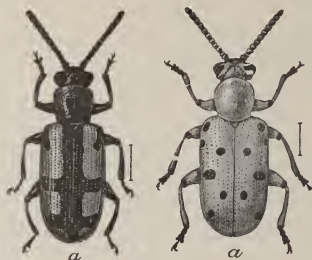


Fig. 49—The Asparagus Beetle, to the left. The Twelve-Spotted Cucumber Beetle, to the right.

beetle will equally apply against this pest. But with this species, we are not troubled with the larva in early spring.

## SOME HOUSEHOLD PESTS.

### THE CLOTHES MOTH.

#### *Tinea pellionella* Linn.

Few insects are more troublesome to housekeepers than the clothes moths. Often the housekeeper will observe the tiny yellowish or buff colored moths flying around the room, sometimes in the daytime, but usually after the lamps are lighted. While the tiny moths themselves do no damage, they do lay the eggs which hatch into the larva and this is the source of injury. The larva feeds upon animal tissue, as hair, feathers and wool, but seldom or never attacks cotton or linen goods.

Remedies: Woolens should be carefully brushed and exposed to the sunlight for a day at least before being packed away. They should be stored in a box or drawer which is moth-proof, if possible, with moth balls scattered around the box or drawer. Clothes may be secured from the clothes moth if they are put in tight paper sacks, if eggs are not already present. The lighter the room where clothing is stored the better, as the moths do not like to work in the light. Infested clothing or other material may be rid of the moth by fumigating with carbon bi-sulphide.

Moth balls, camphor, and tobacco, are often used in dispelling the moths, but if the pest is already present these materials will not prevent them from doing their usual injuries.

## THE CARPET BEETLE—BUFFALO MOTH.

*Anthrenus scrophulariae* Linn.

This insect often causes annoyance to the housekeeper in that its larva is destructive to carpets, rugs, etc. While generally known as the "buffalo moth" from the tufted appearance of the larva, yet the adult insect is a beetle, the wings of which are marked with two irregular white scaly bands, with a slight amount of red. They pass the winter in the adult state, appearing in spring and flying into the open windows and doors of the house and there deposit their eggs in the carpets or other woollens.

Remedies: This pest is rather more difficult to eradicate than the clothes moth. However the same preventative methods can be employed. Infested material may be fumigated with carbon bi-sulphide. gasoline can also be used with satisfactory results.

## THE CROTON BUG—COCKROACH.

*Blutella germanica* Linn.

In houses, surrounding sinks, water pipes, etc., the "croton bug" commonly called cockroach may often be seen, hiding during the day. In the night, however, they come forth sometimes in large numbers giving much trouble.

Remedies: Many poisonous mixtures have been employed to eradicate these insects. Powdered borax alone or mixed with chocolate, dusted in crevices where the insects hide, will give some relief as the bugs are very fond of chocolate, and the borax is poisonous to them. Many destroy these bugs with hot water, where circumstances will allow its use.

## THE BED BUG.

*Klinophilos lectularia* Linn.

No pest of the household is so objectionable as the bed bug. It also avoids the light, and is often unseen and not suspected in sleeping apartments where it is present in large numbers. The bug hides in crevices of bedsteads, mattresses, cracks in the wall, etc.

Remedies: Cleanliness with this as well as with other household pests is essential as a preventative. Where the pest is present, pouring boiling water in their holes, washing the bedsteads with kerosene, and fumigating with carbon bi-sulphide, or hydrocyanic acid gas, will give some relief. Continue the warfare from time to time until eradicated.

## TERMITE—WHITE ANT.

*Leucotermes flavipes* Koll.

While this is not nearly so common as the preceding pests, yet at times these insects are the cause of considerable damage. They often do their injury, before being detected, by riddling the woodwork of furniture and buildings. In injuring wood, they seldom come to the surface but riddle the centre, and in such cases cause the infested wood to collapse, when it is not suspected to have been weakened.

These insects are more common in woodlands where they inhabit any log or decaying tree.

Remedies: When present in buildings it is usually best to destroy the infested wood. Sometimes injecting carbon bi-sulphide into their galleries would destroy them. It is always advisable to find the nest, whether it be in the house or out of doors in some old stump. They can then be destroyed by hot water or kerosene.

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MISCELLANEOUS INSECTS.

## THE CECROPIA MOTH.

*Samia cecropia* Linn.

Food Plants: Apple, plum, various forest trees, etc.

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POLYPHEMUS MOTH.*Telea polphemus* Cramer.

Food Plants: Apple, plum, oak, maple, etc.

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THE LUNA MOTH.*Tropaea luna* Linn.

Food Plants: Hickory, walnut, etc.

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THE SILK WORM.*Bombyx mori* Linn.

Food Plants: Mulberry, etc.

THE REGAL MOTH.

*Citheronia regalis* Fab.

Food Plants: Hickory and various trees and shrubs.

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THE IMPERIAL MOTH.

*Basilona imperialis* Drury.

Food Plants: Hickory, butternut and other species of forest trees.

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THE HOG SPHINX.

*Ampelophaga myron* Cramer.

Food Plants: Grape, etc.

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THE TWO-SPOTTED SPHINX.

*Smerinthus jamaicensis* Drury.

Food Plants: Apple, plum, elm and willow, etc.

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THE WHITE-LINED SPHINX.

*Deilephila lineata* Fab.

Food Plants: Apple, plum, currant, grape, etc.

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THE SALT MARSH CATERPILLAR.

*Estigmene acraea* Drury.

Food Plants: Various herbaceous plants.

## THE ISABELLA TIGER MOTH.

*Isia isabella* Smith & Abbot.

Food Plants: Various herbaceous plants.

## THE ILIA UNDERWING.

*Catocola ilia* Cramer.

Food Plants: Oak, hickory, etc.

## THE YELLOW SWALLOW TAIL.

*Papilio turnus* Linn.

Food Plants: Caraway, parsnip.

## THE RED ADMIRAL.

*Vanessa atlanta* Linn.

Food Plants: Nettle, hop, etc.

## THE MORNING CLOAK BUTTERFLY.

*Euvanesa antiopa* Linn.

Food Plants: Poplar, willow, etc.

## THE MONARCH.

*Anosia plexippus* Linn.

Food Plants: Milkweed.

THE VICEROY.

*Basilarchia archippus* Cramer.

Food Plants: Willow, poplar, aspen, etc.

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THE GREAT SPANGLED FRITILLARY.

*Argynnis cybele* Fab.

Food Plants: Violets, etc.

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THE CLOUDED SULFUR.

*Eurymus philodice* Godart.

Food Plants: Clover, etc.

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THE SILVER SPOTTED SKIPPER.

*Epargyreus tityrus* Fab.

Food Plants: Locusts, etc.

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Injury from the larvae of any of these moths or butterflies cited above can be controlled by the application of an arsenite.

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SOME BENEFICIAL INSECTS.

LADY-BIRD BEETLES.

Among the beneficial insects as a class, the lady-bird beetles are the most important. They are especially distinguished for feeding on various scale insects, and plant lice. While some members of the family are injurious the majority are predaceous.

## THE NINE-SPOTTED LADY-BIRD.

*Coccinella novemnotata* Hbst.

The larva of this little lady-bird is useful in destroying plant lice. The beetle is about one-fourth of an inch long, with black head and body. The wing covers are orange-yellow marked with nine black spots. They hibernate during the winter appearing early in the spring and immediately commence laying eggs. There are several generations in a season.

## THE TWO-SPOTTED LADY-BIRD.

*Adalia bipunctata* Linn.

This species is slightly smaller than the preceding one, and is marked by having a black spot on each wing cover. It also feeds on plant lice.

## THE SPOTTED LADY-BIRD.

*Megilla maculata* DeG.

This beetle shown in Figure 50 is quite useful to asparagus grow-



Fig. 50—The Spotted Lady-Bird; a, larva; b, empty pupal skin; c, beetle, all enlarged.

ers as its larva feed quite ravenously on the larvae of the asparagus beetles.

## THE TWICE-STABBED LADY-BIRD.

*Chilocorus bivulnerus* Muls.

This species is about three-sixteenths of an inch in length and width, marked by having a red spot on each elytron. The insect is predaceous on scale insects. It is often found attacking the San Jose scale, but the number they destroy is never sufficient to hold the scale in check without artificial remedies.

## THE ASIATIC LADY-BIRD.

*Chilocorus similis* Rossi.

This lady-bird was introduced from Japan with the aim that it may prove a great factor in controlling the San Jose scale, as it was found feeding on that pest in its native land.

The beetle resembles very closely the preceding species in shape and markings. It is somewhat smaller. It seems to have done good work in the south, but it is feared that our winters are too severe for it.

*Pentilia misella* Lec.

This little beetle is much smaller than the species previously mentioned. It seems, however, to be more useful in destroying the scale than any other beneficial insect but only in exceptional cases has its assistance been felt to any extent.

## THE GROUND BEETLES.

The ground beetles are another class of insects which assist the farmer by destroying large numbers of injurious pests. These beetles usually remain under rubbish or shelter of any kind. They are seldom seen during the day, but come out from their hiding places at night, the majority being able to fly. The fact that they remain in the ground or under rubbish aids them in securing noxious insects, which pass a part or all of their existence in the soil.

## THE SEARCHER.

*Calosoma scrutator* Fab.

This is a brilliant-green beetle and one of the largest of the family. It is rather out of the ordinary of ground beetles being that it often ascends trees and feeds on caterpillars. For this reason it is sometimes called the "caterpillar hunter." In orchards they are sometimes just below the surface of the soil and close to the base of the trees.

## THE FIERY GROUND-BEETLE.

*Calosoma calidum* Fab.

This little beetle receives its common name from having its wing covers dusted with bright gold. Its larva is an enemy to cutworms,



Fig. 51.—The Fiery Ground Beetle; a, beetle; b, larva.

while not larger than the cutworm, its strong prominent jaws assist them in killing their prey. Figure 51 shows the beetle and larva.

## THE MURKY GROUND-BEETLE.

*Harpalus caliginosus* Fab.

This beetle is particularly helpful to fruit-growers on account of its larva feeding on curculio larvae. The adult is a rather large black beetle about one inch long and one-half inch wide.

## THE WHEEL BUG.

*Arilus cristatus* Linn.

Orchardists often observe a large mass of little jug-shaped eggs about a half inch in diameter, stuck to a limb of a peach or apple tree and thereupon destroy them, thinking that they hatch into an insect injurious to his crop. This is not the case, however, for they hatch into the wheel bug, which feeds upon various other noxious insects. The adult bug is quite large having a semi-circular crest, the edge of which is toothed, on its thorax or back. It attacks all kinds of insects, piercing them with its beak and sucking their juices.

## ICHNEUMON FLY.

*Thalessa lunator* Fab.

This large ichneumon fly is often seen at times forcing its long ovipositor into the bark of trees in which there are borers working.

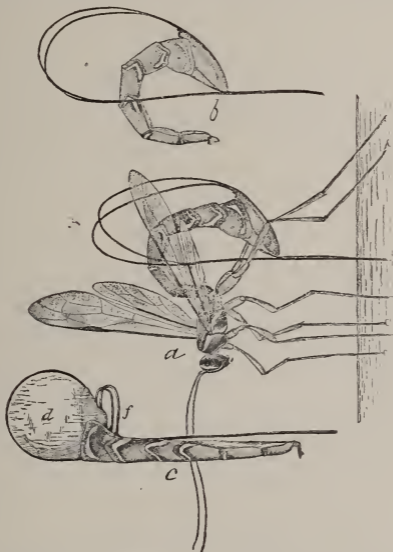


Fig. 52—The Ichneumon Fly; a, female in act of ovipositing.

When the ovipositor reaches the burrow of the wood-boring larva, the insect then deposits an egg, which soon hatches and the larva crawls along in the burrow until it reaches its host. It then pierces the skin and gradually kills the borer by sucking the juices. Figure 52 illustrates the insect.

## SYRPHUS FLIES.

*Melanostonua mellinum*.

The larva of this species as well as others are very active in destroying plant lice. Much attention was given the syrphus fly larva when the pea louse was doing so much injury in this State.

It is hoped that a more extended account of the beneficial insects will be given later, giving illustrations of all the more common forms.

## COMMON INSECTICIDES AND REPELLENTS.

In combating insect attacks it is of prime importance that the grower be able to distinguish the manner in which the insect does its injury. For without this knowledge, he may apply a stomach poison to an insect with the hope of destroying it, when in fact the insect may do its injury by sucking the juices from the plant. We therefore have the two main divisions, first, insects that do their injury by eating, in combating which we usually employ a stomach poison and secondly, insects which do their injury by sucking the juices of the plants, in which case, it is usual to apply contact insecticides, gases, etc.

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## STOMACH POISONS.

## PARIS GREEN.

Paris green 1-4 to 1-3 pounds in 50 gallons of water.

This well-known arsenite is commonly used in combating biting insects. While there are other arsenites which are cheaper and possibly their purity can be more usually depended upon, yet this is such a widely known insecticide it is generally recommended by entomologists.

It is often combined with Bordeaux mixture, a fungicide, in the same proportions as above, substituting Bordeaux mixture for the water. The combination is then an insecticide as well as a fungicide.

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## GREEN ARSENOID.

This powder is somewhat lighter than Paris green and probably superior to it in composition. It also remains in suspension for a longer period. It can be used in the same proportions as Paris green.

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## ARSENATE OF LEAD.

This arsenite is used by many in preference to Paris green for it is the least caustic in its effect upon foliage and remains in suspension and adheres to foliage for a longer period. This can be used at any strength from 1½ to 6 pounds to 50 gallons of water.

A mixture called "Disparene" is practically the same as arsenate of lead and is said to be somewhat more adhesive than the regular arsenate.

## CONTACT INSECTICIDES.

## LIME, SULFUR AND SALT.

Fresh stone lime, 20 pounds.  
 Flowers of sulfur, 15 pounds.  
 Common salt, 10 pounds.  
 Water to make 50 gallons.

Boil 20 gallons of water in an iron pot or hog scalding, now add the 20 pounds of lime, also the sulfur, which should have been previously mixed with a little hot water to form a paste. Add the salt a little later when the mass is boiling. If the water was boiling when the lime and sulfur were added, in about thirty minutes, if the mass has cooked vigorously, the sulfur should be thoroughly dissolved, producing a clear amber colored solution. Now add the amount of hot or cold water to make 50 gallons and apply warm.

## LIME, SULFUR AND CAUSTIC SODA WASH.

When it is impracticable to cook the solution, as described above, one can be made as follows, without cooking, which will be fairly effective.

Stone lime, 30 pounds.  
 Flowers of sulfur, 15 pounds.  
 Caustic soda, 8 pounds.  
 Water, 50 gallons.

Dissolve the caustic soda in water, and stir it into the sulfur, which has previously been made into a paste, then use this solution for slacking the lime. Slack the lime as it should be for a good white wash then dilute the whole to fifty gallons and strain into a barrel and use at once.

## KEROSENE EMULSION.

Kerosene, 2 gallons.  
 Common soap,  $\frac{1}{2}$  pound.  
 Water, 1 gallon.

Dissolve the soap in boiling water, add the kerosene and emulsify by violent churning. Dilute to the required strength.

## KEROSENE LIME EMULSION.

Same as above except that unslacked lime is used in place of the soap.

## CRUDE PETROLEUM.

Can be used in the above formula but should be applied only when trees or plants are in dormant state.

## WHALE OIL SOAP.

For scale insects used at the rate of two pounds to the gallon of water as a winter wash.

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## TOBACCO.

Old tobacco stems are often steeped in hot water, a pound of the stems to a gallon or two of water. It is used as a spray against plant lice. Also burning old tobacco stems in a greenhouse is helpful in destroying several pests.

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## "ROSE LEAF."

This is an extract of tobacco sold by the gallon. It is exceedingly strong, diluting thirty to forty times with water in spraying to control aphids.

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## TOBACCO DUST.

Tobacco dust is a good insecticide to put around the roots of young trees when planting in order to control the woolly aphis, or black peach aphis. In addition it is somewhat of a fertilizer.

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## HYDROCYANIC ACID GAS.

This gas has come into use of late years as an important insecticide. Its use in fumigating trees infested with San Jose scale has become quite general. It is made by combining the following:

Cyanide of Potassium, 98 per cent., 1 ounce.

Sulphuric Acid (Commercial), 2 ounces.

Water, 4 ounces.

This formula will fumigate an enclosure containing 100 cubic feet. Place acid in an earthen jar then add water and cyanide. Be sure to have the room or enclosure air tight, or nearly so. Keep everything closed for at least 30 minutes. It is a very deadly gas and much care should be exercised with its use.

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## BI-SULPHIDE OF CARBON.

This liquid is used in destroying stored grain insects and the like and also some pests under ground, but principally the former. The liquid evaporates very rapidly, the gas being deadly to animal life when confined in it for any length of time. In fumigating grain or other

similar material use one to three pounds of the liquid to 100 bushels of grain. The gas is exceedingly explosive; therefore, do not allow any light, cigar or pipe around the building when fumigating. It is sometimes injected into the soil around the roots of the plant to destroy certain pests. In such cases a tablespoonful of the liquid injected a short distance from the plant would be sufficient.

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#### NAPHTHALINE MOTH BALLS.

These balls when placed in a tight box or drawer make a good repellent for clothes moths and similar insects.

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#### PRESERVATION OF SPECIMENS.

One case in the exhibit shows the various instruments and contrivances for collecting and preserving specimens, including mounting board, pinning block, microscope mount and collecting net.

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#### CREDIT FOR ILLUSTRATIONS.

Figures 10, 11, 13, 20, 21, 27, 29, 33 (a, b, c and e. Riley and Howard), 34 and 36 after Howard, Bureau Ent. U. S. Dep't Agric.

Figures 1, 2, 19, 22 and 23 after Marlatt, U. S. Dep't Agric.

Figures 3, 4, 24, 25, 26, 35 and 50 after Chittenden, U. S. Dep't Agric.

Figures 17 and 42 after Saunders.

Figures 18 and 41 Sanderson (pupa) Riley.

Figures 48 after Johnson.

Figures 7, 8, 12, 15, 16, 31, 32, 37, 38, 39, 40, 44, 45, 46, 47, 51, and 52 after Riley.

Figure 30 Packard, Third Rep't Ent. Com.

Figure 9 Alwood, Va., C. P. C. No. 45.

Figure 28, photograph by R. I. Smith.

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#### GLOSSARY.

**AERIAL:** Occurring in the air; used here in reference to insects occurring in the branches of trees.

**ALKALINE:** Pertaining to or containing one of the Alkali metals.

**ARSENITE:** A salt of arsenious acid.

**ARSENATE:** A salt of arsenic acid.

**BEETLE:** An insect having biting mouth-parts, and horny wing covers.

**BUG:** An insect having sucking mouth-parts, the first pair of wings thickened at base and membranous at tip.

SATURNIIDAE: A family of moths containing the giant silk

TERMINAL: A terminating point, end.

CHRYsalis: The pupa of Lepidoptera.

COCOON: Covering made by a larva in which it changes to a chrysalis or pupa.

CORRODE: To eat away gradually.

CRUCIFERAE: A large family of plants, including the mustard.

DECOCTION: The liquid produced by boiling a substance until its soluble properties are extracted.

EFFICACIOUS: Producing an intended effect.

ELYTRON: A thickened wing cover.

EXCRESCENCES: Unnatural or disfiguring out-growths.

EXCRETED: The throwing off of waste matter by normal discharge from any organism.

FUNGUS: A plant destitute of Chlorophyl and deriving nourishment wholly or almost wholly from organic compounds.

FUNGICIDE: Anything that kills fungi or destroys their germs.

HIBERNATE: To pass the winter, especially in a secluded place and in a torpid state.

HIBERNATION: The act or time of hibernating.

HYDROCYANIC ACID GAS: A deadly gas which is thrown off when Pot. Cyanide, sulfuric acid and water are combined.

INSIPID: Without flavor, tasteless.

INSECTICIDE: A material that kills insects.

LARVA: Second stage of an insect's life.

LEPIDOPTERA: A class of insects including moths and butterflies.

MANDIBLE: A part of the mouth which serves for seizing prey.

MILLIMETER: About 1-25 of an inch.

OVIPOSITION: The act of depositing an egg.

PARASITE: An organism that lives on or in some organism for the whole or part of its existence.

PEFORATES: to bore through.

PERIODICAL: Recurring after a definite interval.

POSTERIOR: The hinder part.

PUPA: Third stage of an insect's life.

REPELLENT: A liquid or other material serving to repel the attacks of insects.

SATURNIIDAE: A family of moths containing the giant silk worms.

SEGMENT: One of the parts into which an object is naturally divided.

SOLANACEOUS: An order of plants including the potato and night-shade families.

SPECIES: A group of plants or animals subordinate to a genus, and having members that differ among themselves only in minor details.

SPHINGIDAE: A family of moths including the hawk-moths or sphinxes.

TERMINAL: A terminating point, end.

# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

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## LEUCOCYTES IN MILK AND THEIR SIGNIFICANCE.

BY CHARLES F. DOANE.

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In the planning and carrying out of this work, Dr. S. S. Buckley, Veterinarian of the Station, has taken an active part. In devising the new method for counting the leucocytes in milk, he is equally responsible with the writer. In other details his knowledge of pathology has been indispensable to the success of the investigation.

The writer is also indebted to Dr. H. E. Lawson, of the Office of Experiment Stations, United States Department of Agriculture, who has taken an active interest in the work, and has given many practical suggestions.

There is a constantly growing tendency to investigate all the conditions which are likely to have any influence on the value of milk as a food. Particularly is this true as regards those conditions which are likely to have any influence on the health of the consumer. Milk is used largely as a food for infants and the sick under conditions where anything, though it be very little, is wrong, may mean the loss of many lives, and this is sufficient excuse to follow up every hint that may lead to the uncovering or disclosing of some unhealthy condition. It is often argued that knowledge is ahead of practice at the present time and that if what is already known in regard to improving milk were applied, it would make a great difference in the quality of milk sold to consumers. The investigator must always be far ahead of the so-called practical man. New ideas are adopted with great caution, as a rule, and were the investigator to wait until the public demanded additional knowledge, progress would be very slow indeed.

It has long been known that under certain conditions of the cow's udder abnormal milk is produced. The exact nature of this milk has never been determined. In extreme cases it comes from the udder in strings. The udder may become so clogged with this hard and stringy milk that nothing can be drawn from it. It has been pretty generally understood that this trouble is due to inflammation of the udder, and that under these conditions the milk was not fit for human consumption. It is entirely possible for an abscess to form in the udder, in which case the purulent matter, common to such disease, would be given off into the milk. It has been supposed that the man in charge of the cows or the milkers could tell when this unfavorable condition occurred, in which case, of course, the milk could be rejected. But where milk is

shipped this diseased milk could be included without fear of detection. Occasionally, through an epizootic, an entire herd might be troubled with inflamed udders, in which case some pretty bad milk might be shipped, and the consumer or authorities would have no means of detecting the fault or fraud. It can be seen at once that any means whereby the presence of diseased milk could be easily detected might possibly be made of great value as an additional safeguard to the health of the consumer.

The most natural clue would be in determining if the milk contained material that resembled pus. Pus is made up largely of white blood corpuscles or leucocytes, and the demonstration of leucocytes in milk might be taken as an indication of pus, and, consequently, the fact that the milk came from a diseased udder, and was therefore unfit for human consumption.

#### STOKES METHOD OF DETERMINING LEUCOCYTES.

The first writer to call particular attention to the presence of leucocytes in milk was Dr. William R. Stokes, Bacteriologist to the Baltimore Board of Health. He devised a method for estimating the comparative number of leucocytes in milk from different sources, and conducted a line of investigations to determine the number of leucocytes present in the milk of individual cows of herds kept under different conditions.

In 1899 Dr. G. L. Eastes published, in the *British Medical Journal*, the results of an examination of 186 samples of milk, in which the character and comparative number of cells present in the milk were discussed.

In 1904, Dr. D. H. Bergey, of the University of Pennsylvania, in a bulletin of the Pennsylvania Department of Agriculture, discussed various phases of the presence of leucocytes in milk. He used the Stokes method of comparing the number. Particular parts of this work will be taken up again, but a study of the work already done will show the unsatisfactory state of the knowledge on the subject. This is particularly true as regards the method for estimating the number of leucocytes, and the arbitrary standard adopted as indicating an unhealthy condition of the udder. The method was as follows: Ten cubic centimeters of milk was run in a physician's centrifuge for five minutes. The cream and milk were then poured off, allowing the sediment to remain in the bottom of the tube. The tube was then allowed to stand for an instant, until a few drops of the milk had gathered at the bottom, when the contents were stirred up with a platinum loop. A loopful of the contents smeared over a coverslip was heated by passing through a gas flame, and was then stained with methylene blue. This was put under the microscope, using the 1-12 objective. A number of fields were counted, and the average for one field taken as the indicated number of leucocytes.

That the foregoing method was much better than none is of course evident, as are also its shortcomings. There is but one element of

scientific accuracy in the whole process. In the first place, the sediment varied in quantity, usually with the number of leucocytes, but not necessarily so, and while the sediment varied in quantity the same loop was used. Again, a loopful is a rather indefinite quantity, and it may be smeared in varying thicknesses over the cover slip. In fact, the only accurate feature of the entire process was the using of a definite quantity of milk.

#### DOANE-BUCKLEY METHOD OF DETERMINING LEUCOCYTES.

As was stated, the need for a more accurate method for counting was at once apparent when the work was undertaken at this Station, and the first efforts were to secure such, if possible. We think we have succeeded by the utilization of the blood counter employed by physicians in diagnosing a number of diseases. This little instrument was devised for counting the number of corpuscles present in the blood, and it lent itself very naturally to our purpose. In short, it is a small glass chamber, very accurately made, and holding a known quantity of liquid, one ten-thousandth part of a cubic centimeter. It can be used under the 1-6 objective on the microscope, and permits of an accurate count of the number of leucocytes present. With this method ten cubic centimeters of milk are centrifuged for four minutes in graduated sedimentation tubes, at an approximate speed of 2000 revolutions per minute. The cream is lifted out with a cotton swab, care being taken to get as much of the fat out as possible. It is then centrifuged for one minute more, and the cream again removed with a cotton swab. Any fat remaining in the milk interferes seriously with the counting, as, if there are more than a few globules, they form a layer at the top of the liquid in the counting chamber, and as the leucocytes settle to the bottom of the chamber, it is difficult to see through the fat. It is only with cows giving milk difficult of separation where this trouble is experienced, and with such animals considerable care is necessary in removing all of the cream gathered at the top of the sedimentation tube. The method of removing the fat with cotton is the best one that has occurred to us, and is the only part of the process that does not operate with entire satisfaction in every instance.

Following the removal of the cream, after the second centrifuging, the bottom of the tube will contain a portion of sediment which is easily seen. This sediment may, in extreme cases of cows suffering with garget, amount to as much as one cubic centimeter. Ordinarily, it will be considerably less than one-half cubic centimeter. The amount varies considerably with the number of leucocytes, but not absolutely. The milk above this sediment is removed with a small syphon, which can be easily arranged with bent glass rods drawn to a fine point and supplied with a small rubber and a pinch cock. In using the syphon it is better to keep the point near the surface of the milk in the tube in order not to agitate the precipitated leucocytes and draw a number of them off with the milk. The milk in the tube may be syphoned within an eighth of an inch of the sediment in the tube. This will

usually be below the  $\frac{1}{2}$  cc mark. Two drops of a saturated alcoholic solution of methylene blue are then added, thoroughly mixed with the sediment by shaking and then set in boiling water for two or three minutes to assist the leucocytes in taking up the color. The contents of the tube can be boiled by holding it directly in the flame, but it has no advantages over the use of the water bath, and it is very likely to break the glass. After heating, some water is added to the tube to render the color less dense. Ordinarily filling the tube to the 1 cc mark will be sufficient, and this quantity gives an easy factor for calculating the final results.

In putting this liquid, containing the leucocytes, into the blood counter, considerable care is necessary, owing to the tendency of the leucocytes to sink to the bottom. At this place a capillary tube was used, and the cover glass was held in one hand ready to cover the chamber as soon as the drop was transferred to the counter. After placing the glass cover over the chamber, about a minute is required allow the leucocytes to settle to the bottom of the chamber. There are very few foreign bodies that are likely to be mistaken for leucocytes in counting. Ordinarily the poly-nuclear leucocytes predominate, and the stained nuclei, with the unstained surrounding cell, shows up very distinctly. A few small leucocytes with large nuclei may be found, and these may be confounded with yeast cells until the worker becomes familiar with the distinction.

As regards counting, we have taken a standard with a cubic centimeter as a basis quantity of milk, though we are of course aware that the corpuscles in the blood are enumerated with the cubic millimeter basis. We adopted the centimeter largely for two reasons. In counting bacteria in the milk the cubic centimeter is always the basis employed. Simply because the leucocytes were derived from the blood seemed to be no reason why the same basis for counting should be employed as was used with the blood, while to the ordinary bacteriological worker, to whom this work will fall if ever adopted to any extent, the cubic centimeter standard would be a little more easily comprehended because more frequently used. The blood-counter holds one-tenth cubic millimeter, and one ten-thousandth cubic centimeter. If ten cubic centimeters of milk are used, and one cubic centimeter of fluid is in the tube after syphoning, and the coloring matter and the water to dilute have been added, then the resulting number of leucocytes in the counter multiplied by 1000 will be the total number of leucocytes per cubic centimeter in the milk. If a total of 75 leucocytes was counted in the chamber there would be 75,000 leucocytes per cubic centimeter in the milk.

In the actual counting under the microscope a square millimeter of the counting chamber will be found to be ruled off into 400 smaller equal squares. This facilitates an accurate and rapid count. Where the number of leucocytes is not great, the entire field can be counted in a short time. Where there is a great number of leucocytes a few squares or sets of squares in different parts of the ruled surface will give approximately the number.

There are occasionally a few variations desirable from these rules, but it may be well to state that the details have been pretty carefully and thoroughly worked over and compared, and it is seldom that short cuts can be made if correct results are desired. The time and speed of centrifuging are placed as low as possible for accurate work. Where there is one-half centimeter or more of sediment, it is necessary to use more of the methylene blue for staining, and as there will be too great a number of leucocytes to make a satisfactory count in the counting chamber, it is better to add water until there are two cubic centimeters, or sometimes even more in the sedimentation tube.

This method of counting, while long in explaining, is in reality comparatively short and simple in application. Moreover, it is based on accurate measurements in every detail, and the results are correspondingly reliable.

#### COMPARISON OF METHODS.

The author used the method in some comparative tests with the Stokes method, a man thoroughly familiar with the Stokes method applying the latter, both methods being carried through at the same time on the same samples of milk.

The following table gives the comparative results:

TABLE I.

*Comparing old and new method for counting leucocytes.*

| Sample No. | Stokes Method:<br>Leucocytes per Field. | Doane-Buckley<br>New Method:<br>Leucocytes per cc. |
|------------|---|--|
| 1          | 22                                      | 1,024,000  |
| 2          | 10                                      | 525,000  |
| 3          | 30                                      | 468,000  |
| 4          | 10                                      | 500,000  |
| 5          | 17                                      | 292,000  |
| 6          | 100                                     | 1,500,000  |
| 7          | 35                                      | 328,000  |
| 8          | 125                                     | 3,200,000  |
| 9          | 28                                      | 716,000  |

Table I shows some pretty widely varying comparative results.

For instance, samples two and three had very nearly the same number of leucocytes, while with the Stokes' method the latter showed three times as many per field as the former. Other comparisons in the tables show the same variations. This bears out a former statement that while the Stokes' method gave some indication of the number of leucocytes, it was far from accurate, and to that extent unreliable.

## NUMBER OF LEUCOCYTES IN COWS' MILK.

As soon as we had our method perfected we made a count of the leucocytes in the milk of the cows in the Station Herd. This was repeated at intervals, and the following table shows the result:

TABLE II.

*Count of leucocytes per cc in milk from cows of Experiment Station herd.*

| Cow No. | Dec. 15th,<br>Leucocytes<br>per cc. | Jan. 4th,<br>Leucocytes<br>per cc. | March 1st.<br>Leucocytes<br>per cc. |
|---------|-------------------------------------|------------------------------------|-------------------------------------|
| 35      | 116,000                             | 15,000                             | .....                               |
| 37      | 126,000                             | 32,000                             | .....                               |
| 39      | 37,000                              | 400,000                            | 190,000                             |
| 50      | 180,000                             | 10,000                             | 300,000                             |
| 54      | 106,000                             | .....                              | 192,000                             |
| 55      | .....                               | .....                              | 40,000                              |
| 56      | 1,000,000                           | 1,600,000                          | 27,000                              |
| 58      | 25,000                              | 14,000                             | 82,000                              |
| 61      | 36,000                              | 20,000                             | 136,000                             |
| 65      | 75,000                              | 12,000                             | 29,000                              |
| 69      | 30,000                              | .....                              | 8,000                               |
| 70      | 79,000                              | 93,000                             | .....                               |
| 71      | 36,000                              | 16,000                             | .....                               |
| 72      | .....                               | 5,000                              | 25,000                              |
| 75      | 10,000                              | 165,000                            | .....                               |
| 76      | 7,000                               | 19,000                             | .....                               |
| 78      | 70,000                              | 17,000                             | 124,000                             |
| 79      | 42,000                              | 64,000                             | 40,000                              |
| 80      | 47,000                              | 480,000                            | 52,000                              |
| 82      | 41,000                              | 19,000                             | .....                               |
| 83      | 4,000                               | 6,000                              | .....                               |
| 84      | 145,000                             | 44,000                             | 68,000                              |
| 85      | 112,000                             | 3,000                              | .....                               |
| 86      | 200,000                             | 640,000                            | 214,000                             |
| 87      | 320,000                             | 11,000                             | 28,000                              |

At about the same time that the count was made with the Station herd, the writer paid a visit to one of the large cities and made an examination of the milk from the cows in one of the best and most carefully-kept herds in the United States. The following table shows the results:

TABLE III.

| Cow No. | Leucocytes per cc. | Cow No. | Leucocytes per cc. | Cow No. | Leucocytes per cc. |
|---------|--------------------|---------|--------------------|---------|--------------------|
| 1       | 35,000             | 37      | 128,000            | 73      | 17,000             |
| 2       | 12,000             | 38      | 365,000            | 74      | 292,000            |
| 3       | 10,000             | 39      | 25,000             | 75      | 1,500,000          |
| 4       | 105,000            | 40      | 312,000            | 76      | 328,000            |
| 5       | 120,000            | 41      | 4,000              | 77      | 76,000             |
| 6       | 230,000            | 42      | 76,000             | 78      | 3,200,000          |
| 7       | 365,000            | 43      | 126,000            | 79      | 116,000            |
| 8       | 355,000            | 44      | 37,000             | 80      | 716,000            |
| 9       | 39,000             | 45      | 32,000             | 81      | 232,000            |
| 10      | 106,000            | 46      | 241,000            | 82      | 75,000             |
| 11      | 232,000            | 47      | 1,040,000          | 83      | 87,000             |
| 12      | 33,000             | 48      | 84,000             | 84      | 145,000            |
| 13      | 284,000            | 49      | 4,600,000          | 85      | 21,000             |
| 14      | 63,000             | 50      | 188,000            | 86      | 15,000             |
| 15      | 155,000            | 51      | 30,000             | 87      | 154,000            |
| 16      | 51,000             | 52      | 16,000             | 88      | 38,000             |
| 17      | 256,000            | 53      | 19,000             | 89      | 197,000            |
| 18      | 112,000            | 54      | 216,000            | 90      | 45,000             |
| 19      | 140,000            | 55      | 8,000              | 91      | 104,000            |
| 20      | 32,000             | 56      | 12,000             | 92      | 148,000            |
| 21      | 1,024,000          | 57      | 500,000            | 93      | 268,000            |
| 22      | 52,000             | 58      | 72,000             | 94      | 105,000            |
| 23      | 525,000            | 59      | 6,000              | 95      | 980,000            |
| 24      | 468,000            | 60      | 122,000            | 96      | 148,000            |
| 25      | 58,000             | 61      | 75,000             | 97      | 24,000             |
| 26      | 18,000             | 62      | 27,000             | 98      | 18,000             |
| 27      | 1,288,000          | 63      | 165,000            | 99      | 48,000             |
| 28      | 63,000             | 64      | 2,000              | 100     | 115,000            |
| 29      | 67,000             | 65      | 35,000             | 101     | 216,000            |
| 30      | 9,000              | 66      | 80,000             | 102     | 75,000             |
| 31      | 5,000              | 67      | 16,000             | ..      | .....              |
| 32      | 10,000             | 68      | 35,000             | ..      | ....               |
| 33      | 13,000             | 69      | 20,000             | ..      | .....              |
| 34      | 11,000             | 70      | 4,000              | ..      | .....              |
| 35      | 8,000              | 71      | 2,000              | ..      | .....              |
| 36      | 15,000             | 72      | 68,000             | ..      | .....              |

After the first count had been made with the Station herd, the writer became curious to know if it were possible to find milk without leucocytes. This was largely the reason for making the count recorded

in Table III. As both the Station and the latter herds are looked after with more than ordinary care, it would appear that the milk would at least be as pure as from the great majority of herds. No cow in either herd gave milk free from leucocytes. To test this further, milk was taken separately from each quarter of some of the cows in the Station herd, and, following this, samples of the first and last milk in each quarter were taken, the cows selected for this purpose being the ones whose milk had shown a low count. The following table gives the results:

TABLE IV.

*Leucocytes per cubic centimeter in milk from quarters of cows' udders.*

| Date.   | Cow. | Left Front. | Left Hind. | Right Front. | Right Hind. |
|---------|------|-------------|------------|--------------|-------------|
| Dec. 22 | 69   | 9,000       | 2,000      | 5,000        | 77,000      |
| " 23    | 69   | 2,000       | 7,000      | 5,000        | 63,000      |
| " 23    | 83   | 15,000      | 8,000      | 4,000        | 14,000      |
| " 23    | 39   | 25,000      | 275,000    | 29,000       | 96,000      |
| " 27    | 39   | 31,000      | 800,000    | 45,000       | 49,000      |
| " 27    | 83   | 23,000      | 10,000     | 17,000       | 35,000      |
| " 29    | 69   | 1,000       | 3,000      | 9,000        | 56,000      |
| *Jan. 4 | 85   | 2,000       | 1,000      | 2,000        | 1,000       |
| †" 4    | 85   | 2,000       | 2,000      | 2,000        | 3,000       |

\*First milk from quarter.

†Last milk from quarter.

From tables II, III and IV some interesting conclusions can be drawn. The first is that leucocytes are evidently natural to the milk; or, at least, for all practical purposes may be considered natural. The tables show that not one sample of milk was examined in which leucocytes could not be found, even when the examination was from the milk from separate quarters of the udders of cows giving a small leucocyte count.

Bergey and Eastes both hinted that it was probable that leucocytes were never absent from milk, but it appears that neither had very satisfactory proof. With the Stokes method of counting, used by Bergey, it was often the case that no leucocytes could be found on the prepared coverslip, while Eastes' work was largely done with milk from herds and not from individual cows.

Another interesting fact shown by the tables is the very large number of leucocytes present in the milk. It runs into the thousands in each cubic centimeter with most cows, while, in some cases, there

are millions per cubic centimeter present. As far as is known, at the present time, this variation indicates nothing in certain limits. The same variation in numbers is seen in the milk from different quarters of the same udder, and there is considerable variation in the same quarter from day to day, as is shown in Table IV with the milk from cow No. 69. It would appear that about the only constant feature in the number of leucocytes found in the milk of different animals is that a cow giving a low count one day will give a comparatively low count the next. There is such a wide variation in the number of leucocytes in the milk from different cows that the milk from one cow can vary considerably from one day to another, and yet give results comparatively similar.

#### LEUCOCYTES AND PUS.

As has already been stated, leucocytes are usually associated in our minds with pus, and it is known that they make up a very great part of pus. On this ground the presence of leucocytes in milk has been taken as an indication that some inflamed condition of the udder existed, and that the leucocytes came from this source. This being true, of course the milk would be of questionable healthfulness as an article of diet, especially for the infants and the sick. But is the presence of leucocytes in milk necessarily an indication of a diseased condition? As shown by one investigation, and hinted by Bergey, leucocytes are evidently present in milk, excepting in such extremely rare cases as to indicate that they are a natural constituent of the milk. It has been agreed that the udder of the cow is in an exposed position, and is subject to such frequent injury that the leucocytes, even in small numbers, may be an indication of a slight inflammation due to a bruise. This is very much to be doubted. There may be some doubt as to the ease with which the yielding mass of the cow's udder is injured sufficiently to set up even a slight inflammation, but it is exceedingly improbable that the animal would receive constantly recurring injuries in every quarter of the udder as to make the leucocytes invariably present in the milk.

There seems to be but the one conclusion, which is that, either in the elaboration of the milk in the udder, or through the intimate association of the blood vessels with the glands, leucocytes escape through into the milk. The udder is not the only gland where this occurs. The urine generally contains leucocytes; and this when post mortem examinations have shown definitely that there was no disease or abnormal condition to give rise to their presence. On the other hand, it has been demonstrated that when a very great number of leucocytes were present in the milk there was evidently inflammation present in the udder. Or it might be better to state it the other way, when there is evident inflammation of the udder, as shown by thick milk, or hardness of one or more of the quarters, there is always an abnormally large number of leucocytes. Reassuring in another way, inflammation in the udder would produce pus if at all severe. Pus has a large number of

leucocytes, therefore, their presence in the milk would naturally be taken as an indication of pus. But in view of the varying number of leucocytes with different cows, what standard shall be taken as the limit for healthy milk? It is evident at once that such a standard must be largely a matter of guess work and purely arbitrary, unless some other indication of the presence of pus, aside from a mere number of leucocytes, can be found.

Stokes started out by considering that five leucocytes per field indicated that the number had passed the natural or safe point. It is somewhat difficult to understand, at the present time, on just what grounds he based his conclusions. It would appear, seeing he made no statement to the contrary, that he regarded any leucocytes at all as evidence of an abnormal state, and simply drew the line at five per field to suit the exigencies of the case. For instance, he found a large number of cows with leucocytes in the milk. The number of cows was too great to think of excluding all from furnishing milk for consumption, and so the limit was placed at five leucocytes per field. This eliminated a few cows, not enough under the best conditions to cause too much objection, and the work to be discredited. Stokes has evidently broadened out this original number in his own mind, and in a recent communication to the writer he suggested twenty to twenty-five per field as being a safe estimate, stating that he was evidently too low in his original standard. Bergey has adopted ten leucocytes per field as an indication of pus, while Eastes simply said a large number, leaving himself plenty of room.

This change and variation in opinion makes it necessary for new light. What was evidently needed was information which would make it easier to identify pus, and the investigation materially merged into a study of this product of disease. In undertaking this work the most notable feature was the almost utter lack of literature bearing upon this subject that would be of any assistance. Medical literature is almost barren of any discussion or the record of any research work done to discover the nature of pus other than was evident to the eye. A few articles were found all of which ended with the statement that exact work to determine the nature of pus had never been carried out. There are numberless statements to the effect that investigations on this subject were needed, but had never been made. In a few cases, suggestions were made. It was stated that a large number of polynuclear cells was an indication of pus. Another assertion was found to the effect that a large proportion of eosinophiles was proof of pus, while still another assertion that a brownian movement of the eosinophile granules was an indication that the leucocytes were getting ready to disintegrate.

That pus is made up largely of leucocytes is evident, but the definition given for pus as dead and disintegrating leucocytes, while universally accepted, does not carry any definite meaning when the leucocytes are dead. With the present knowledge it is doubtful if the definition is absolutely accurate and discriminating. Pus, as ordinarily considered, cannot, except in a very few pathological conditions, be

disassociated from an inflammation. The work presented in this bulletin, and some other work on the presence of leucocytes in urine, would make it appear more than probable that large numbers of dead leucocytes may be encountered when there is no evidence of any inflamed condition, without which it is exceedingly improbable that the leucocytes are an indication of pus.

It is a little difficult to understand why, in view of the great activity along pathological lines, no one has undertaken the study of pus. The only explanation that could be offered is that the external appearances of pus and the causes which give rise to its formation have been so evident to the eye that there seemingly has been no particular need of making a detailed study for the purpose of identification. But in the study of leucocytes in milk and their significance the need of some method of identifying pus, aside from merely the fact that it was made up largely of leucocytes, was at once apparent, and the lack of such a means severely felt.

Bergey attempted to supply this needed information by making a study of the bacteria usually associated with pus. In many instances he found streptocci in milk. It would appear from his report that the streptocci were in greater numbers in milk containing an abnormal number of leucocytes. From his results he drew the conclusion that the combination of leucocytes and streptocci were an indication of the presence of pus. It must be said, however, that Bergey got some big counts of leucocytes where he did not find the associated bacteria; and, on the other hand, found the bacteria where he did not find the leucocytes. Moreover, certain difficulties stand in the way of a practical application of Bergey's idea. In the first place, the milk must be either fresh from the udder of the cow, or packed in ice when fresh, to keep other kinds of bacteria from developing and destroying the value of the results. Furthermore, the work of growing and differentiating bacteria is such an endless operation that to attempt to apply it, in a practical way, would serve at once to put the method out of use entirely. Something more easily applied and requiring less time is needed. Bergey was not entirely satisfied with the plan, for he still clung to and recommended his arbitrary number of ten leucocytes per field as being an indication of pus. It has been suggested that the streptocci could be demonstrated with the leucocytes in the microscopic field when counting the leucocytes by the Stokes method, but this is difficult and impracticable.

At this Station we undertook to make an extended study of pus to determine, if possible, its characteristics. To obtain the necessary material a seton was introduced under the skin of the hip of a healthy dairy cow. The exudate from the resulting inflammation was followed through microscopically and an effort was made to distinguish any difference of the leucocytes in the various periods of the inflammation and those found in the fresh blood. The various untested theories were tested. A large number of different stains were tried. The theory that pus contained a large proportion of eosinophiles was proven to be incorrect, as they were in about the same proportion as in the

fresh blood preparation. The brownian movement of the eosinophiles was looked after, but indicated nothing. The statement that a large proportion of polynuclear cells indicated pus may apply under many conditions, but as the cells found in the milk are largely polynuclear, even when found in small numbers, the theory does not assist for this particular work.

#### FIBRIN IN PUS.

It was in making this study of the pus that our attention was drawn to the large number or masses of threads which did not absorb the colors used, and simply appeared as refractory lines under the microscope. In a trial stain with carbol fuchsin these threads when spread thinly on the coverslip showed up very distinctly a bright red color. Some time after this, while making a microscopic examination of the sediment from milk containing a very large number of leucocytes, and from a cow with a slight attack of garget, a small slimy mass was seen clinging to the side of the tube. When transferred to the coverslip and stained with carbol fuchsin, the same threads were observed as in the pus. An inquiry among pathologists led to the knowledge that fibrin is supposed to be associated with pus from inflammatory wounds or lesions, especially in severe cases, though very little prominence has been given to this fact.

After finding the mass of fibrin in the sediment from the milk, other milk with a high leucocyte count was examined for the same material. Occasionally it was found, sometimes not. Two tubes of milk taken from the same lot would show fibrin in one tube and not in the other. Small portions of pus from the seton induced inflammation were added to tubes of milk, centrifuged, and an effort made to recover this with the platinum loop, and stain on the coverslip. It was found that it was not always possible to recover this fibrin. It had been noted previously that even when the fibrin was present, in such masses as could be seen by the naked eye in the tube, it was very difficult to get this out with the platinum loop. The fibrin seemed to cling very closely to the glass of the tube. This difficulty was finally remedied by taking a folded wad of filter paper sticking on the end of a pin, and absorbing the sediment in the bottom of the tube. All of the fluid and most of the leucocytes would be absorbed into the paper. The fibrin would remain on the surface, and could be easily be smeared on the coverslip. This method gives positive results.

The next step in the investigation was to get a good stain. The carbol fuchsin worked very well when the material was smeared sufficiently thin on the coverslip. But this stain is taken up by practically all organic material in liberal quantities, so that it is very hard to distinguish or find the fibrin threads. In smearing the material from the filter paper a thin layer of milk serum naturally covered all the surface of the coverslip. This was very thin, but was enough to take up sufficient carbol fuchsin to practically make it impossible to find fibrin if it was present. Most of the fibrin stains are difficult of appli-

cation and we had to get out an entirely new stain. Delafield's hematoxylin was found to give fair results when applied for several hours. By adding 15% of carbolic acid to the hematoxylin a stain was secured that would act in less than ten minutes, staining the fibrin threads a dark blue or purple, the nuclei of the cells black and the dried milk serum a light purple. This was then stained with eosin, which gave everything but the threads and the nuclei a bright red stain. This made it very easy to distinguish the fibrin threads from the rest of the material on the coverslip. This stain when rightly prepared gives about as perfect results as any stain could give. It needs, however, to be made up fresh very often.

The finding of the fibrin associated with the leucocytes is undoubtedly an important step in the leucocyte theory for diseased udders. In no case has it been possible to find the fibrin masses with a low leucocyte count. In nearly all milk single threads of fibrin will appear on the coverslip, and this will be spoken of again; but the masses of fibrin, large numbers of threads running parallel and holding blood cells, have been found only under conditions where the combination of fibrin threads with a large leucocyte count made it practically certain that a diseased condition of the udder existed. In some cases, hardness of the udder existed. In other cases, stringy milk showed trouble, while, in still other cases, nothing but the leucocyte count and the fibrin masses showed that any disease was present. Three examples of these different phases will be taken as illustrative.

On the evening of March 9th, cow No. 39 was found to have a hard quarter. Milk from this quarter showed a leucocyte count of 15,000,000 per cubic centimeter, and considerable fibrin. March 10th leucocyte count was 20,000,000 per cubic centimeter and masses of fibrin; March 12th, 6,800,000 leucocytes per cubic centimeter and fibrin; March 13th, mixed milk from all quarters, 520,000 leucocytes per cubic centimeter and no fibrin.

March 28th an incidental count of the leucocytes of the milk from a number of cows in the herd showed a count of 1,500,000 cells per cubic centimeter in the milk of cow No. 50. A large mass of fibrin was present. The count diminished, with the fibrin constantly present, until only 500,000 leucocytes were found, when no more fibrin could be demonstrated. At no time during this period was there any stringy milk or any hardness in the udder. A leucocyte count showed 1,450,000 per cubic centimeter. Masses of fibrin were present. This condition persisted for a number of days without any noticeable change in any feature. The animal was giving only about a quart at a milking, and she was dried off.

When Eastes published his work on leucocytes he mentioned the presence of "mucin-like threads" being associated in a few cases with a large leucocyte count. He called attention to the fact that similar threads were found in pus, and stated that their presence in milk, with a large number of leucocytes, was an additional indication of pus. He failed, however, to demonstrate these threads in some of his samples with a high cell count, and evidently from diseased udders. His

trouble, without a doubt, lay in the difficulty to transfer the fibrin threads from the sedimentation tube to the coverslip. He explained the discrepancy on grounds showing his evident unfamiliarity with the cow's udder.

The presence of fibrin in pus gives rise to a fairly satisfactory and rapid means of determining the presence of pus in milk. The milk threads catch and retain large numbers of leucocytes in a mass. This is particularly noticeable when the blood counter is used. If no fibrin is present the leucocytes will be distributed singly or, at most, five or six gathered together. If any quantity of fibrin is present large numbers of leucocytes, from 20 to 100 in a single mass, will be seen under the microscope. At the same time there will be large numbers of cells to be seen singly. It is very doubtful if these clumps can be seen in many instances with the Stokes method of counting, except in the rare cases where the platinum loop happens to take up a portion of the fibrin in the tube. There can be little doubt that these leucocyte masses or clumps furnish the most practical and the easiest means of determining the presence of pus and the healthfulness of the milk. In adopting this means it would be well to shake the sediment up well after coloring, to be sure that no masses of leucocytes have clung together when fibrin is not present. When there is only a small number of leucocytes there is no need of expecting the clumps, but when a large number appears in the counting chamber then a search could be made for clumps. They will not be difficult to find if they are present.

Hergey mentions, in his work, that the presence of masses of leucocytes was an additional indication of pus, but he did not explain why, and, moreover, with the Stokes method used by Bergey, clumps appeared very seldom, and where they did appear fibrin could be demonstrated with them.

#### FIBRIN AND THE NUMBER OF LEUCOCYTES.

With these additional means of distinguishing pus it is interesting to know about how many leucocytes are actually present when the milk evidently contains pus. As was stated with two of the three cows noted as special cases, the first fibrin noted was after the milk had a leucocyte count of about 1,000,000 per cubic centimeter, and the fibrin persisted until the amount was reduced to 500,000. This, of course, means of the mixed milk of all four quarters, while in both cases only one quarter was affected. As will be pointed out further along, one quarter may be seriously affected without the other quarters showing an increased leucocyte count. Judging from these, and other figures we have, of a similar nature, it would appear that milk with a leucocyte count of 500,000 per cubic centimeter is suspicious, while when it reaches 1,000,000 per cubic centimeter, there is undoubtedly inflammation in the udder. In view of this, and in considering the comparative tests of the Stokes method of counting with the blood counter, it would certainly appear that the early standard of Stokes and the one recommended by Bergey were too low for many animals.

In Table I cows Nos. 2 and 4 had a count that would make them suspicious and showed 10 leucocytes per field, by the Stokes method, while Nos. 3, 7 and 9 were above this. The truth of the matter is that the Stokes method was so grossly unreliable that any count below fifty per field could not be accepted as showing the milk was suspicious. In truth, counting leucocytes with the blood counter, or in any way putting dependence on the number of leucocytes is very unsatisfactory. The presence of fibrin, as shown by clumps of leucocytes in the blood counter, or, as demonstrated by stained threads, combined with an abnormal number of leucocytes is the only satisfactory proof that inflammation exists in the udder. Without the fibrin any serious inflammation is to be doubted. There are pertinent questions concerning the extensiveness and persistence of an inflammation of the udder. It is interesting to know, if, when one quarter of the cow's udder is seriously affected there is any probability that the other quarter will be similarly affected, or will produce milk which it is advisable to use. It seems to be generally understood that the quarters of the udder are entirely distinct, with no connection, except that perhaps they are supplied by the same blood vessels. No openings evidently exist from one quarter of the udder to another. Judging from this, any diseased condition arising from infection would have to pass from one quarter to another, the same as from one cow to another, though, of course, it would pass more easily.

To test the influence of a diseased quarter on the other quarters of the udder, the milk was taken separately from each quarter of the udder from a cow producing milk with a particularly high count. The following table shows the result:

TABLE V.

| Date.   | Cow No. | L. Front.  | L. Hind.  | R. Front.  | R. Hind.  |
|---------|---------|------------|-----------|------------|-----------|
| Dec. 20 | 56      | 7,000      | 163,000   | 24,000,000 | 561,000   |
| " 20    | 86      | 10,000,000 | 670,000   | 365,000    | 218,000   |
| " 21    | 56      | 1,160,000  | 162,000   | 9,600,000  | 246,000   |
| " 21    | 86      | 10,000     | 390,000   | 800,000    | 6,400,000 |
| " 22    | 56      | 5,000      | 280,000   | 17,000,000 | 5,700,000 |
| " 22    | 86      | 1,500,000  | 570,000   | 516,000    | 700,000   |
| * " 28  | 56      | 8,000      | 1,000,000 | 50,000,000 | 1,000,000 |
| † " 28  | 56      | 16,000     | 960,000   | 1,500,000  | 3,300,000 |
| * " 28  | 86      | 14,000     | 35,000    | 136,000    | 125,000   |
| † " 28  | 86      | 21,000     | 2,000,000 | * 450,000  | 300,000   |

\*First milk from quarter.

†Last milk from quarter.

It would appear from the figures in Table V that one quarter may be seriously affected without all of the other quarters showing any similar results. With cow No. 56, on December 20th, the right front quarter had an exceedingly high count of leucocytes, while only one other quarter was suspicious, and the two remaining showed comparatively low cell counts. It might be said that, at this period, No. 56 had a case of severe inflammation in the right front quarter, as was evident by the fact that the quarter was very hard and badly swollen. The quarter gave a diminished quantity of milk, though it was, to all outward appearances, as good as any milk. The other quarters showed no outward evidence of disease, though eventually the garget extended to another quarter which was as severely affected as was the right front quarter at the time of the counts given in the table.

Some radical and unexplained variations can be seen in the results of the count with the milk of cow No. 86 from one day to another. Had not the writer supervised the taking of these samples, and exercised the greatest care to prevent confusion, he would doubt the reliability of the results of the counts on the 20th and 21st of the month. As we had not, at that time, found out the importance of fibrin in these investigations this additional test could not be applied.

Attention is again called to the fact that the leucocyte count may vary without evident reason, from one day to another, and, also, that the number of leucocytes in the first and last milk from the udder are practically the same.

#### PERSISTENCE OF HIGH COUNT.

There are a number of questions that can be considered under this head. It has been stated that when once a cow suffers from a severe attack of garget a chronic inflammation will persist that will render the milk unfit for use at any subsequent time. This being so, a cow that had ever suffered from a severe case of garget would never be fit for dairy purposes again. It is very doubtful, however, if this is correct. The cow No. 56, considered in Table V, had a severe attack of garget, at this time, that persisted in two quarters, one quarter following the other for a total of about two months. It looked for a time as though the quarters affected would be entirely destroyed for producing milk, but it will be noticed that at the last count of the leucocytes the number had gotten very low, and the affected quarters are producing milk. There have been two other severe cases of garget in the Station herd, one of which caused the loss of a quarter of the udder, but, though the other quarters were affected, the cow, No. 37, gives milk as free from leucocytes, practically, as any cow in the herd. The other cow had but one quarter affected, though it was very bad, but she now gives milk that is not at all suspicious.

There are cows which seem to suffer from a sort of periodical garget that appears at irregular intervals. These attacks, as with cow No. 39, used as an illustration of the presence of fibrin, usually last for a very few days, a week being a long time, comparatively. These attacks, as pointed out, may be accompanied by either hardness

of the udder or the giving of stringy milk, or these symptoms may not be present, as pointed out with cow No. 50. What causes the recurrence of this trouble has not been explained, and would be interesting to know. There can be no doubt that the milk is unfit for use during the attacks and should be rejected, but between the attacks the milk is evidently perfectly healthy. But there comes an important question as to what shall be done with such cows? Where the disease occurs too often and where the milk is intended for a particular dairy, the cow should not be allowed in the dairy. Otherwise, there is room for discussion and difference of opinion. These cows are likely to be among the most valuable in the herds from a producing standpoint, and as the trouble is not uncommon it is expecting considerable to ask that all such cows be sold for beef.

As pointed out with cow No. 65, there is a possibility that as the cow approaches the end of her lactation period the udder may become inflamed and produce stringy milk. This has been noted with a considerable number of cows in the Station herd. Such cows can be dried up at once. In fact it is very likely true that the milk from most cows should not be used after they stop giving at least two pounds at a milking, or about one-half gallon per day.

#### APPLICATION OF TEST.

The practical use of the leucocyte and fibrin test for unhealthy milk remains for the future. Eastes and Bergey are of the opinion that the presence of pus in the milk will account for a large part of the summer sickness of children. Eastes mentioned one case where it appeared that a large amount of sickness among the children of an English village was due to milk coming from diseased udders. Additional proof and demonstration of these theories is needed, and when it is produced there can be no doubt that the application of the remedy will follow gradually. In the meanwhile, the test will undoubtedly be applied to individual animals in herds supplying milk for special purposes, as in the Walker-Gorden laboratories. That the test could be applied by health authorities to milk coming from different farms to determine if the herd, on the whole, was healthy, is possible, even practical. There would doubtless be cases where the test thus applied would be valuable and would indicate if contagious garget were present in the herd.

#### NATURAL FIBRIN IN MILK.

In 1888, Dr. S. M. Babcock announced the theory that fibrin was a natural constituent of milk. This is better called a theory than a fact, because Dr. Babcock was never able to demonstrate the fibrin, his reasons being based entirely on certain phenomena. He advanced several different arguments in support of his theory, and they will be briefly stated. First and foremost was a decided evolution of oxygen. It had been supposed for many years that fibrin had the power of liberating oxygen from hydrogen peroxide, and was one of the very

few organic substances that had this property. This assumption of Dr. Babcock's is known now to have been without foundation, as the organic enzymes are very active in liberating oxygen from hydrogen peroxide, and milk contains two such enzymes, one of which is practically active in this regard.

Another reason was based on the grouping of the fat globules in the milk. When the milk was fresh he pointed out that the globules were evenly distributed, as shown by the microscope, while when the milk has been allowed to stand for a sufficient time to allow the fibrin threads to form, the fat globules were grouped together like blood cells in a blood clot. He further pointed out that if chemicals, which were known to have the power of preventing the formation of fibrin threads in blood, were added to the milk, the fat globules retained their even distribution through the milk, and, furthermore, the rising of the fat globules to the surface of the milk was more rapid and complete. Still another reason was that when fresh milk was cooled to a temperature below that at which fibrin threads could form, the fat globules came to the surface more rapidly and complete. This was the practical application of his fibrin theory.

Aside from the liberation of oxygen from hydrogen peroxide, these arguments hold as good today as when they were advanced, and Dr. Babcock has always clung to his theory, though, as stated, he never was able to actually demonstrate the fibrin.

The writer believes that the fibrin can be demonstrated with a microscope, and he has done this on a number of occasions. It was pointed out in the first part of this bulletin that where any inflammation of the udder exists, fibrin and white blood cells are given off, and this fibrin can be centrifuged out of the milk and smeared on a coverglass, and stained so that the threads are easily demonstrated by the use of a microscope. As was stated, when this inflammation existed the fibrin could be seen as a large number or mass of parallel threads, and was associated with a vast number of leucocytes. It was noticed in looking for fibrin, in the sediment of milk, with a particularly small leucocyte count, that an occasional single fibrin thread would be seen. They were very few in number, and it was seldom that more than one thread could be seen in one microscopic field. They were so evidently like the threads found in the pus in all their characteristics that there was no reason for doubting that they were fibrin.

The presence of the fibrin could not always be demonstrated in the known healthy milk by centrifuging. Two other means of securing it were tried. One was to allow the cream to rise on the milk, on the theory that a large part of the fibrin would be carried into the cream by the fat globules. A small portion of the cream was poured on several layers of filtered paper, to absorb as much of the milk serum as possible. The resulting layer of fat was then scraped from the filter paper, and washed in a beaker with ether to dissolve the fat. This was then filtered, and the residue smeared on coverslips, stained with carbolized hematoxylin and then with eosin. A few fibrin threads were demonstrated in this manner.

Another plan was to filter the milk through a hardened filter. This filter resembles parchment and is designed to stand suction. Milk filters very slowly by this means, and there can be little doubt that any fibrin threads are retained. The resultant filtrate was scraped into a beaker, washed with ether, filtered again, and the filtrate smeared on coverslips, and stained in the usual way. This method worked very satisfactory in most instances, and the fibrin threads were easily demonstrated. This work should confirm Babcock's fibrin theory.

#### STRINGY MILK.

Another interesting demonstration of fibrin in milk was made while on this work. One of the clots of stringy milk in the milk of cow No. 65, discussed in the first part of this bulletin, was smeared on a coverslip and stained for fibrin in the usual manner. It was found to consist largely of fibrin. Other clots were obtained and stained until the conclusion was reached that the fibrin was largely responsible for this stringy milk. There is evidently a considerable quantity of precipitated caesin held together by the fibrin threads, but it appeared as though the fibrin was responsible largely for the clots as they appeared in the milk.



# THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

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## METHODS OF TOBACCO SEED SELECTION.

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### GENERAL FACTORS OF IMPORTANCE.

No farm crop presents a greater necessity for careful seed selection in accordance with the latest and most improved methods than tobacco. This need is plainly evident to the careful observer in almost any tobacco field, and particularly in the tobacco fields of Maryland, where great variation between individual plants is found and the yield is comparatively small.

The average yield of Maryland tobacco is about 650 pounds per acre—much smaller than that of other important tobacco-producing States. The yield has deteriorated very materially in recent years, the crop has become more variable, and consequently less valuable. This variability results in a large proportion of the crop being poorly adapted to the purposes for which it is grown, and greatly increases the cost of sorting and grading.

From the dealer's standpoint, the varieties of tobacco which are now grown in Maryland may be classified into two grand divisions, namely, the German or Holland, and French types. Only a comparatively small part of the crop fully meets the requirements of either of the market standards of these classes. This condition, together with the variation among individual plants found in the field, is sufficient evidence of the necessity for systematic seed selection.

The present types of tobacco grown in Maryland can be classified only in a very general way in the field. An occasional crop is found which presents considerable uniformity and is comparatively true to an established type, but for the most part uniformity in type is lacking, and often as many as half a dozen or more separate and distinct types can be found recurring at frequent intervals in a single field. Each of these types will differ in yield and quality, as well as adaptability, to the common requirements. The variation does not end here, however, but there are marked differences between the individual plants within a given type. In each type there are great variations in shape,

size and number of leaves, the time of maturity of individual plants, size of vein and texture of leaves, and the general habit of growth of the plants. These variations have usually been attributed wholly to differences in the character and fertility of the soil upon which the plants are grown. While this soil variation is in part responsible, careful observation will show that differences exist in the same field among individual plants growing side by side, planted on the same date, and under as nearly uniform soil and cultural conditions as it is possible to secure. Plants producing a large number of leaves are found growing beside plants producing but few leaves, and similar variations and marked differences are found to exist with regard to all the characters of the plant. The writer has observed plants growing side by side under the same conditions which vary in number of leaves from 12 to 32, and as marked differences may be observed in other important factors that add to, or detract from, the value of the plants.

Recent breeding experiments with cigar wrapper tobaccos have conclusively demonstrated the possibility of securing very considerable increase in yield, and very great improvement in the uniformity of type and of the individual plants within the type, by seed selection. These two factors are of vital importance to the tobacco grower, and worthy of the closest attention. Other characteristics, such as burning quality and color and texture of leaf, are also very important, and can be largely controlled through careful seed selection. In these experiments all the important characteristics of the plant were transmitted to the progeny with marked regularity. The original tobacco produced in Maryland was probably pure and true to type; but seed has been introduced from time to time from many other States and from foreign countries, which has resulted in an intermixture of varieties. As a result, numerous undesirable types reappear in considerable proportion every year. These are doubtless the result of hybridization and of reversions to remote ancestors. Under the ordinary method of selecting tobacco seed, it would take many years to breed up a uniform variety under the most favorable conditions, because of the ease with which the tobacco flowers are cross-fertilized.

It is not believed to be desirable for Maryland tobacco growers to introduce seed of improved varieties, in quantity, from other sections. Such importations of tobacco seed are usually disappointing to the grower in respect to yield and quality, and are of little value until several crops have been grown from such seed, and the variety has become acclimatized. Seed should be selected from the best types in the community where the tobacco is grown, thus avoiding the possibility of losses incurred during the process of acclimatization. The differences in the character of soil on adjoining farms is often so marked that it is essentially important that the tobacco grower select his seed in his own field, if a desirable type can be found there.

The tobacco plant is naturally self-fertile. In order to secure best results in the development of a uniform, desirable type of tobacco it is of vital importance that the seed be protected from cross-fertilization. Under normal conditions, when the seed is raised according to the method in general practise, perhaps more than half the flowers on

the tobacco plant are cross-pollinated by insects or other agencies—insects being responsible for the greater part of the crossing. They are attracted to the flowers by the sweet fluid in the bottom of the flower tube, at the time the pollen sacks are open and the stigma receptive. In passing in and out of flower after flower, pollen is carried from plant to plant, and cross-fertilization takes place. This condition results in a large proportion of the crop the following year being hybrid plants, and leads to great variability. No matter how carefully the seed plants are selected, it is practically impossible to secure a uniform crop unless cross-fertilization is prevented by artificial means. This is easily accomplished by bagging the flower heads of the seed plants in the manner described later in this article.

Experiments conducted in the Connecticut Valley with cigar wrapper tobacco by the United States Department of Agriculture have demonstrated the absolute necessity of bagging the tobacco flowers in order to secure uniformity in the crop. Plants grown from seed raised without such protection from cross-fertilization showed considerable irregularity of type, and variations in all the important characters of the plant, while those from bagged seed were remarkably uniform in every particular. It was found also that the seed raised under bag "were larger and heavier, and produced larger and stronger plants than unbagged seed."\* Self-fertilized seed were found to produce more vigorous crops than could be grown from seed cross-fertilized within the variety. When no crossing occurs the progeny will inherit the characters of the single parent plant with striking regularity.

#### METHOD OF SEED SELECTION.

Two selections should be made in the field—a first, or preliminary selection of a considerable number of plants, and later, a more careful selection from among the plants chosen in the first instance.

The first selection of seed plants should be made just before the earliest flowers begin to open, and before any pollination occurs. It is absolutely necessary that the closest attention be given to this part of the work. It cannot be intrusted to hired laborers, but can be successfully done only by the grower himself, whose interest is in the crop.

The grower must decide upon that type of plant which most nearly approaches his ideal. He must carefully select that type which he thinks will produce the largest yield of the most valuable class of tobacco adapted to the purpose for which it is grown.

The formation of a clear conception of this ideal type is of the greatest importance, and worthy of the most careful study and consideration before the actual work of selection begins.

With this ideal clearly fixed in his mind the grower should go over the field row by row, carefully observing each plant, and select forty or fifty plants which most nearly approach this ideal type. The average farmer will not need more than four or five plants to amply supply him with seed for one year's planting, but it is necessary to select this large number in order to afford an opportunity for a second

\*Year Book, U. S. Dept. Agriculture, 1904.

and closer selection in the field. When the second selection is made it is necessary to save fifteen or twenty plants in order that a final selection may be made after the leaves from the seed plants have been cured and compared. Each of the plants originally selected should be marked and given a number to distinguish it from all other plants. A small sized shipping tag of good quality may be used for this purpose. It should be fastened to the stalk by means of a strong cord or small wire. The number must be plainly marked on the tag with a soft lead pencil. Rain will quickly obliterate ink markings.

After making the preliminary selection, each of the forty or fifty individual plants should be studied in detail, and all of the important characters taken into consideration. In making this second and final field selection those plants should be reserved which combine as many of the most desirable characteristics as it is possible to secure. In order to definitely determine upon the best plants it is necessary to make a careful record of the important characters of each of the plants originally marked and numbered and bring these together for comparison. The characters which should be given the closest attention in making up these records are the general habit of growth or type of plant, the number, shape, size and uniformity of leaves, distance between the leaves, time and uniformity of ripening, height of plant, number of suckers, and uniformity of color of leaves.

A careful count of the leaves on each individual will show a wide difference in the number of marketable leaves produced. It is of vital importance to select plants with a large number of leaves, in order to secure an increased yield. The form of leaf can best be determined by actual measurement of the length and width of at least one average leaf on a plant. It will be found that some plants produce leaves of much more desirable shape and size than others, and in some cases the leaves will be found to be comparatively uniform in size from top to bottom, while others vary materially in this respect.

Marked differences will also be observed in the time of ripening of individual plants and of individual leaves upon the plants. In some cases all the leaves from top to bottom ripen practically at the same time, while in others the lower leaves are over-ripe before those near the top of the plant begin to mature. The color of the leaf is a very essential character, and must be kept constantly in mind.

The writer has found by actual count in some tobacco fields in Southern Maryland from 5 to 95 per cent. of the plants affected with mosaic disease, to a greater or less extent. In his opinion and that of many experienced growers this cause seriously affects the quality of the product, and unquestionably retards the growth of the plants and produces deterioration in yield. This disease can be detected by the peculiar unevenness of color of the diseased leaves. They assume a mottled or calico appearance, which cannot be easily overlooked or mistaken. All plants showing the least indication of this disease should be discarded for seed purposes without further examination.

The number of suckers is also quite variable, and should be noted. Seed from plants showing few suckers will produce a small number the following year, and those showing a large number will

transmit that tendency to the progeny, provided other things are equal.

#### GENERAL METHOD OF SEED SELECTION AND BAGGING THE PLANTS.

After the selections of seed plants have been made in the field some means must be employed to protect the flowers from cross pollination. A very simple, cheap, and at the same time effective method, is to cover the flowering part of the plant with an ordinary paper bag. This also serves as a protection against injurious insects. The common 12-pound manilla bag used in most grocery and country stores is admirably adapted for this purpose. It is not easily torn by wind or rain storms, but can be readily renewed if occasion requires it. The 12-pound size gives sufficient room for the proper development of the flower head of an average size tobacco plant, and at the same time is not heavy enough to injure the plant in any way.

The proper time for placing the bag over the plant is just before the earliest flowers begin to open. See Plate I. All small leaves, suckers and lateral branches immediately below the seed head proper should be carefully removed and the mouth of the bag tied around the stalk just under the lowest remaining branches. A properly bagged plant is shown in Plate II.

After five or six days the bag should be temporarily removed and all suckers broken off. It should be replaced at once and elevated a little above its original position in order to give sufficient room for the normal development of the seed head. This operation should be repeated once a week for two or three weeks, or whenever necessary. When most of the seed capsules are about half grown, it has been found desirable to remove the bag and cut off all late flowers, flower buds, and poorly developed capsules, leaving only the largest and best to mature seed. The bag should be replaced after this is done and allowed to remain until the stalks have been cut and seed dried out.

When the seed are fully matured and ready for harvesting, the best results can be obtained by cutting the stalks near the bottom and hanging them up in the attic or some place where there is a free circulation of air until the seed is thoroughly dried out. The bag should be allowed to remain on the stalk during the process of drying, as a protection and to catch any seeds which may fall out as the capsules dry. The number given each plant in the field must remain on the stalk until the cured leaves have been examined and final selections made, if it is possible to study the fermented leaves.

It is desirable to save the leaves from the seed plants and we recommend that as the leaves ripen on the seed plants, they be harvested separately, and those from each plant kept to themselves and carefully labeled. If carefully strung and cured in the barn with other tobacco they will serve as a very important basis for final selection. Leaves from seed plants are not always of as good quality as they would have been had the plants been topped, but where all are saved under equal conditions a fair comparison can be made. After they have been thoroughly cured a careful comparison of the leaves from all the different seed



Plate I—Tobacco Plant with Flowers at Proper Stage of Maturity for Bagging.



Plate II—Tobacco Plant with Flowers Covered by Bag.

plants should be made and seed used for planting selected from those plants which have produced the best seed and most valuable tobacco.

#### USE HEAVY SEED FOR PLANTING.

The superior value of heavy over light tobacco seed and the practicability of separating them has been conclusively demonstrated by experiments conducted in the Plant Breeding Laboratory of the United States Department of Agriculture.

The heavy seed produce the most vigorous and strongest plants, while those grown from light seed are for the most part very inferior and give a very small yield (See Plate III). This is partly due to the larger amount of plant food contained in the heavy seeds.

Notwithstanding the exceedingly minute size of tobacco seed it is easily within the power of every tobacco grower to make a perfect separation of his tobacco seed into light and heavy grades.

The following description and cut of a device for accomplishing this was taken from an article on "The Improvement of Tobacco by Breeding and Selection," by A. D. Shamel, published 1904 in the Year Book of the Department of Agriculture:

"The most satisfactory means of separating the light from the heavy seed is by using a current of air. A simple and effective device for the purpose is shown in Plate IV. The material necessary for constructing this machine can be obtained by tobacco growers from almost any chemical supply house. The foot bellows (a) is connected by means of a rubber tube (b) to the valve tube (c). The glass tube (d) is fitted with a rubber cork (e), in which the valve tube is inserted. The top of the cork is covered with a piece of finely-woven gauze, in order to prevent the seeds from entering the valve tube. About an ounce of seed for separation is placed in the glass tube, and a current of air is injected by means of the foot bellows. The strength of this current must be regulated by the valve (c), so that only the dirt, chaff and light seed will be blown out of the top of the tube. It is advisable to screen out all of the large particles of hulls and trash before putting the seed in the tube."

It is easily within the reach of every tobacco grower in Maryland to select his seed plants in the manner outlined in this bulletin, and to thereby improve his crop without any extra expense and very little labor. The increase in yield of corn and wheat which has resulted from careful seed selection and breeding is sufficient evidence of the possibility of securing a like improvement in the tobacco crop through similar methods. The marked variability of Maryland tobacco and the necessity of securing uniformity of type make this an unusual opportunity for accomplishing good results from careful and systematic seed selection.



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Plate III—Tobacco Seedlings from Light (31-3), Medium (31-2), and Heavy (31-1) Grades of Seed.

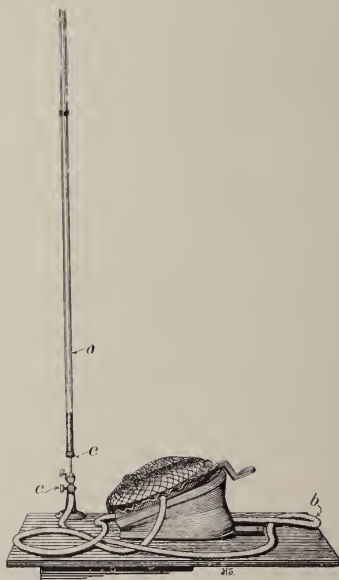


Plate IV -Apparatus for Separating Light  
and Heavy Seed of Tobacco.

## HOW TO PROCURE GOOD TOBACCO SEED.

(Summary.)

1. Save the best plants in the field for seed plants. During the cultivation of the crop, and the suckering and topping processes, a constant search for good plants should be made by growers.

2. When good plants are observed, they should be plainly marked by a tag or rag, tied to the plant, so that they may be easily found, and to prevent them from being accidentally topped.

3. Place a 12-pound manilla paper bag over the flower heads of the selected seed plants before the first flowers open. Inspect the bags every few days for the first two weeks and raise them up farther on the growing stems, arranging them so as to prevent any injury from crowding in the bag during this period of growth.

4. At the end of the season, when the seed pods are ripe, cut off the plants near the ground without removing the bags and hang them up in a dry place. The bags serve to catch the seed which may fall out of the capsules in drying.

5. After the seed has thoroughly dried, shell it out of the capsules, and separate out the heavy seed for use, by the means described in this paper.

6. It would be well for every grower, using this method of seed selection, to save some seed in the ordinary way and plant it for comparison.



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# Maryland Agricultural Experiment Station

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